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Investment Research

Technology and climate change

How big is the investment opportunity?

Introduction

Governments and corporations have made bold commitments to tackle climate change. Initiatives such as the Paris Agreement aim to limit the rise in global temperatures to less than two degrees Celsius above pre-industrial levels by the end of the century.

Numerous bodies of research suggest that failing to cap temperature rises could have major economic and social consequences. The European Commission's *JRC Science for Policy Report* concludes that consumption by EU citizens could fall by EUR 240bn every year at the end of this century if global temperatures exceed pre-industrial levels by more than three degrees Celsius[1].

Should temperatures climb in an unmitigated way (as predicted by the Intergovernmental Panel on Climate Change's RCP 8.5 scenario of an average 0.04 degree Celsius rise in average global temperatures every year until 2100), global real GDP per head could drop by 7% and by 10.5% for the US, based on an August 2019 working paper from the National Bureau of Economic Research[2].

And the World Bank Group finds that, without immediate climate action, another 100 million people could sink into poverty by 2030[3].

Technological solutions and disruptive forces lie at the heart of preventing (and even reversing) climate change. They are also central to unlocking major investment opportunities for corporations and investors.

In this paper, we explore:

1. **The size of the investment opportunity**, including the investment themes that help to counter further climate change and may even contribute to reversing it.
2. **The technologies with wider implications for driving positive changes** from businesses, individuals, investors, and financial institutions to avert climate-damaging activities and/or reverse climate change.

Technologies to better measure climate change

Technological advances will continue to underpin our collective efforts to track climate change. By gaining greater understanding of its historical progression, countries, corporations, and individuals will be able better to assess their preparedness and the potential economic and social impact of it.

We identify three key technological trends driving better measurement and prediction of climate change:

1. **Widespread use of sensors** to collect more comprehensive data from everyday objects. This data should align with the objectives and key performance indicators of the major climate-related UN Sustainable Development Goals (SDGs 7 and 13). Technological advances such as ubiquitous sensors will increasingly capture real world phenomena such as temperature, speed, and heat across industrial systems, utility grids, and transportation systems. They can support new or enhanced approaches to forecasting climate patterns and their impact on populations, resources, and assets.
2. **The Internet of Things (IoT) and 5G wireless networks as an ecosystem** will become a valuable infrastructure that transmits climate change data to governments, corporations, and investors with equality of access. This raw input will define Big Data in that it will be generated at high speed, in vast volumes, and often in highly variable format.
3. **Cloud data centers and machine learning** will use artificial technology systems to transform this Big Data into coherent information that governments, businesses, and investors can analyze to make informed decisions. Technological advances have enabled scientists to quickly create, store and analyze data that, until recently, would have taken years to compile.

Technology and climate change
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Chapter 1

How big is the investment opportunity?

Achieving all the UN Sustainable Development Goals (of which climate change is a part) will require between USD 5trn and USD 7trn of annual investment until 2030, according to the 2017 UBS WEF white paper *Mobilizing private wealth for public good*. As former World Bank President Jim Yong Kim noted at last year's World Bank Meetings, this figure compares to USD 150-160bn of annual official development assistance. Private households, by contrast, have vast savings – US households and non-profits alone held USD 130trn of assets as of June 2019, according to the Federal Reserve.

Private investment is therefore critical to tackling climate change. But where can private investors best deploy their money?

We explore two categories of investment.

The first comprises **thematic investments in technologies and disruptive companies that look to prevent further climate change.** These investments support sustained economic growth by using resources more efficiently and producing fewer emissions of global greenhouse gases (GHG). This section also links to themes that help Executives and Entrepreneurs improve their business operations (by lowering costs, opening new, greener ways of generating revenue, and avoiding environmental degradation).

The second category consists of **investment concepts (often powered by climate technology) that have a positive social impact and the potential to help reverse climate change.**

Please see CIO's **Longer Term Investment themes** (linked on the following pages) and CIO's **Executives and Entrepreneurs hub** for more content.

Thematic investments that counteract further climate change

Energy efficiency

What are the main investible technologies underpinning the theme?

The Internet of Things (IoT) would use sensors or smart tags to enable intelligent network and machine-to-machine interaction. Machines that can predict system failures and trigger maintenance automatically save considerable time and energy, especially in the manufacturing sector. Industry studies by firms such as Ericsson indicate that IoT can reduce energy consumption by up to 25%.

Smart systems apply IoT and artificial intelligence (AI) capabilities to slash energy consumption. For example, smart buildings, complete with building-management systems, centralize resource control and manage lighting, heating, ventilation, and air conditioning systems in an efficient and well-coordinated way.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of computing resources. IT infrastructure-related investments typically account for one-fifth of enterprise capital expenditure. Studies by companies such as Amazon and IBM conclude that enterprises could more than halve their carbon emissions if they migrate their data storage operations to the cloud.

Buildings construction and operation account for:

36%
of global final energy use and

39%
of direct and indirect CO_2 emissions

Source: International Energy Agency and the United Nations Environment Programme (2018)

In which sectors/verticals do these technologies have the greatest potential?

Buildings offer the greatest opportunity for reducing energy consumption. They and their construction currently account for 36% of global final energy use and 39% of direct and indirect CO_2 emissions[4]. In 2018 alone direct emissions from buildings exceeded three gigatons of CO_2[5]. Population growth and urbanization are expected to increase commercial and residential floor space, leading to soaring energy demand. Yet new technologies and techniques for constructing and retrofitting buildings could improve energy efficiency by nearly 40% by 2040, according to the IEA[6].

Traditional electricity supply systems would benefit from an upgrade to a "smart grid." This innovation incorporates decentralized, smaller electricity-generation resources, including solar panels and energy storage (via electric cars). It also enables grid operators to collect data on energy use for the purpose of analyzing electricity demand in real time and adjusting how much of it is generated. A 2010 report from the US Department of Energy (Pacific Northwest National Laboratory) estimated that smart grids could trim electricity use and utility sector carbon emissions by at least 12% by 2030[7].

Transportation is also a sector ripe for disruption. We identify particular promise in mass transit systems, including trains. Video-conferencing and telecommuting via networking technologies can save US and UK businesses billions of dollars while cutting CO_2 emissions by 5.5m metric tons by 2020, equivalent to retiring one million passenger cars from the roads, according to AT&T.

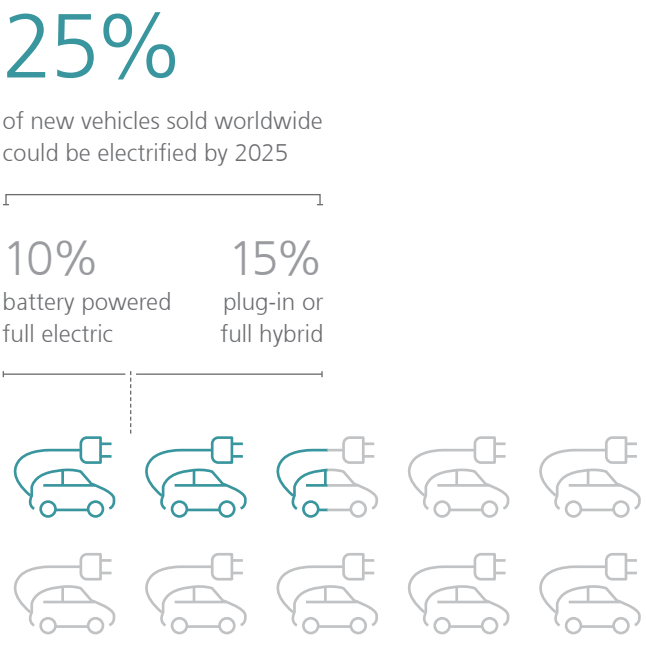
For more information please explore CIO's Longer Term Investment theme: **Energy efficiency.**

Smart mobility

What are the main investible technologies underpinning the theme?

Electrification is critical to reducing per-vehicle CO_2 emissions and replacing internal combustion engines (ICEs) where constraints exist on making further emissions cuts. Its benefits, however, depend on the electricity being generated from sustainable and renewable sources, not fossil fuels. Technological advances in battery cell chemistry and developments that lower the cost and increase the availability of charging infrastructure are also likely to be transformative (although safe recycling and waste disposal of batteries will also be vital to avoid hurting the environment).

Connectivity technologies (such as 5G networks and Big Data analytics) are the building blocks for integrating vehicles into complex systems such as traffic management, charging infrastructures, and communications networks. Quicker and more comprehensive connectivity (between vehicles, and between vehicles and critical infrastructure) will advance the rise of mobility-as-a-service models (such as car sharing and robotaxis).



Source: UBS

In which sectors/verticals do these technologies have the greatest potential?

Electric powertrains will lower GHG emissions by powering either fully electric, hybrid, or plug-in hybrid vehicles. UBS estimates that around 25% of new vehicles sold worldwide could be electrified by 2025, with at least 10% of them being battery electric and the rest plug-in or full hybrids. Electric vehicles in the US emit around 40% less greenhouse gases than conventional vehicles do, according to a US government study (see Figure 1).

Figure 1

Emissions and fuel cost for a 100-mile trip

Vehicle (compact sedans)	Greenhouse Gas Emissions (pounds of CO_2) equivalent	Total Fuel Cost (US Dollars)
Conventional	87 lb CO_2	8.33
Hybrid Electric	57 lb CO_2	5.48
Plug-in Hybrid Electric	62 lb CO_2	5.43
All-Electric	54 lb CO_2	3.74

Source: US Department of Energy

Mobility-as-a-service operating models, such as car hailing and car sharing, can help to cut emissions by making vehicle use more efficient. According to the US's Transportation Sustainability Research Center, each car owned by ridesharing services removes 5.5–12.7 tons of GHG emissions per year.

For more information please explore CIO's Longer Term Investment theme: **Smart mobility.**

Renewable energy

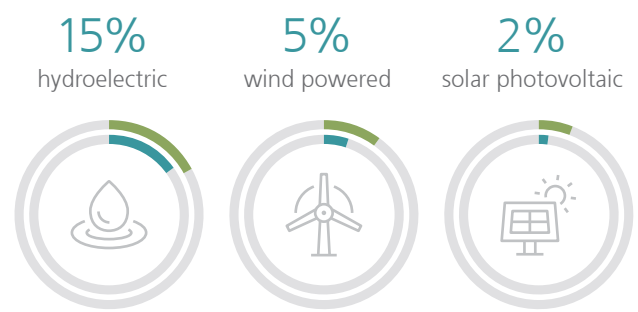
What are the main investible technologies underpinning the theme?

Hydroelectric power's share in global power generation already surpasses 15%, with global capacity topping 1,000 GW and generation hitting 4,100 TWh in 2017. Hydropower is expected to account for 17% of total electricity generation by 2030. Rates of its growth will vary by country because of geographical restrictions and relatively high capital intensity. The International Energy Agency estimated hydroelectric power generation increased over 3% in 2018, but would need to continue to grow at a sustained rate of at least 2.5% every year until 2030 to meet its Sustainable Development Scenario target.

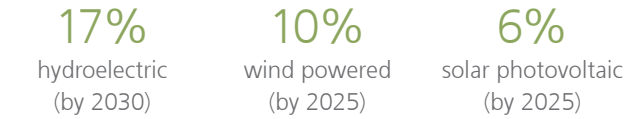
Wind power's total global capacity is expected to exceed 1,000 GW by 2025 (from 600 GW at the end of 2018). Its share of the global power generation mix is forecast to climb to 10% (from today's 4%-5%). Unlike most fossil energy sources, wind power has no fuel costs or exposure to commodity price risk. Operating and maintenance costs are relatively low, and in recent years efficiency has greatly improved.

Solar photovoltaic (PV) global electricity production is anticipated to more than triple by 2025 compared to 2016 levels (based on International Renewable Energy Agency data) and approach 1,400 terawatt hours (TWh). The solar industry has focused on cutting soft costs by optimizing and improving equipment, using robotic technologies, and boosting module efficiency.

Today, global power generation is approximately:



In the future, it's expected to be approximately:



Source: International Energy Agency

In which sectors/verticals do these technologies have the greatest potential?

Power generation accounted for 42% of all energy-related emissions in 2018, according to the International Energy Agency. Power generation (especially coal-fired plants) is particularly carbon intensive. Fulfilling national commitments to limit global temperature rises to two degrees above pre-industrial levels (via reductions in CO_2 output) would require global utility companies to continue switching their energy base from fossil fuel to renewable energy sources.

Solar cells, a kind of semiconductor material, generate energy with one of the lowest carbon footprints of any source. As polysilicon prices and assembly and system-management costs have plummeted, the levelized cost of solar power has become very attractive. When it comes to the carbon intensity of electricity generation, solar cells rate high: every kWh produced by them measures only a fraction of the figure of fossil fuels like coal or oil.

For more information please explore CIO's Longer Term Investment theme: **Renewable energy.**

Automation and robotics

What are the main investible technologies underpinning the theme?

Industrial software presents an opportunity both to considerably reduce emissions and increase investment. Software can help identify energy-inefficient manufacturing activities and propose ways to improve them. When combined with Big Data analytics, it can predict future energy consumption and offer details on how to reduce energy use, helping to prevent further climate change.

Robotics and drones can offer greener production and delivery options than traditional channels reliant on fossil fuels for power. And the use of drones to deliver goods weighing less than 1kg over short distances (2–4km) can also make the e-commerce industry much greener relative to fossil fuel-based transport systems. In agriculture, progress in robotics and drone technology is already enhancing farm productivity and water use efficiency.

In which sectors/verticals do these technologies have the greatest potential?

Precision agriculture can deliver environmental savings to mitigate climate change. Excluding land-use change, agriculture is estimated to account for around 11% of GHG emissions, mainly associated with crop and livestock production, according to the US Environmental Protection Agency[8]. When including land-use change, it accounts for 24% of net emissions based on the same source data[9]. Vertical farming (which typically relies on technologies such as LED lighting, automation, and Big Data to control lighting, heating, and irrigation) is becoming more widespread, reducing water consumption by as much as 99%. It uses no pesticides, herbicides, or fungicides, and needs less fertilizer than traditional agriculture approaches. Conservatively we estimate the market could grow from USD 15bn to USD 90bn by 2030.

E-commerce and its increased adoption should result in consumers traveling less to purchase items, while leveraging the efficient warehousing and logistics platforms of e-commerce providers. A Carnegie Mellon study suggests that e-commerce consumes 35% less energy than the traditional brick-and-mortar retail model.

For more information please explore CIO's Longer Term Investment theme: **Automation and robotics** and CIO's white paper **"The Food Revolution."**

99%

water consumption reduction from vertical farming as compared to conventional agricultural methods

Source: Crop One Holdings

Investment themes with the potential to reverse climate change

Carbon capture and storage (or sequestration) promise to have the largest environmental impact. We expect scalable technologies centered on carbon capture and sequestration, currently under development, to become investable in the next 3-5 years.

Regenerative agriculture that keeps gases in the soil and improves productivity boasts significant potential. At present the global food chain accounts for roughly 30% of GHG emissions and 70% of fresh water consumption (according to a 2019 report from the World Economic Forum), as well as 37.5% of land use (based on a 2017 report from the UN Food and Agriculture Organization). The US National Academy of Sciences (2018) estimated in a study last year that global farmland could reverse climate change by capturing and storing as much as 3 billion more tons of CO_2 if farmers adopted a number of improved practices, including adding organic matter or planting crops that transfer more of their carbon to the soil.

Reforestation and improved land management are also necessary subsidiary practices to achieve true positive environmental impact. For example, in agriculture, the first and most important priority is to stop further land clearances and to conserve or restore peatlands.

The three approaches outlined above must be developed in a way that makes economic sense and actively reverses the effects of climate change rather than just avoiding further fossil fuel emissions. Investment opportunities in these fields are in their early stages, and chiefly confined to private markets.

These three approaches also lack wider industry uptake and rapid commercialization. For example, the International Energy Agency reports that only two large-scale carbon capture projects were operating at the end of 2018, with combined capture capacity of 2.4 million tons of CO_2 per annum (just 0.7% of the IEA's Sustainable Development Scenario target for 2030).

350 million

tons of CO_2 per annum capture capacity target for 2030

0.7%

of the IEA's Sustainable Development Scenario target for 2030

2.4 million

tons of CO_2 per annum capture capacity at the end of 2018

Source: International Energy Agency

This statement contains views which originate from outside Chief Investment Office Global Wealth Management (CIO GWM). It is therefore possible that the statement does not fully reflect the views of CIO GWM.

External interview

Cyrill Gutsch, Parley for the Oceans

Technology, collaboration, and eco-innovation key to preserving our oceans and tackling climate change

The world's oceans play a key role in tackling climate change and capturing carbon. Cyrill Gutsch, award-winning designer, founder of Parley for the Oceans, and a UBS Global Visionary, discusses how technology can support cleaner oceans and positive environmental impact.

UBS: How important are the oceans in protecting us from climate change?

Cyrill Gutsch: It's hard to put into words how vital the oceans really are. Globally, they've absorbed most of the heat and carbon dioxide human beings have produced since the industrial revolution. In doing so, the oceans have become warmer and more acidic, threatening marine life. And all that life, the tiny creatures and plankton and fish and whales, is what keeps the oceans healthy. So it's a cycle, and it's a cycle we're disrupting. The oceans have protected us—now it's our turn to protect the oceans.

UBS: What technologies are helping us to preserve the oceans?

Cyrill Gutsch: Technology, collaboration, and eco-innovation are key. The oceans are so vast that no one country or technology can solve this problem alone, we must work together. To develop a scalable model for government and industry-led responses to major ocean and climate threats requires us to avoid, intercept, and redesign so fewer harmful materials enter our oceans. Future technology, renewable energy solutions, and new research and development will be needed to develop a new economy in which harmful materials become relics of the toxic past.

UBS: How can technology help us all to tackle climate change and even reverse it through the oceans?

Cyrill Gutsch: There is no magic bullet that will fix everything in five years. But with the right ideas, we can use the oceans and future technologies to make a real impact. Kelp and seaweed farming and remediation, what we're calling Deep Carbon, could draw down huge amounts of CO_2 and enable us to scale up biomaterials. Robotics and small satellites will play a key role, and of course protecting ocean wildlife, especially whales and plankton, has huge benefits for the carbon cycle. For example, using drones to study whales in a non-invasive way can provide lots of data that can be used to educate others on how to use technology for the oceans' benefit, including placing this technology on submarines to build a more comprehensive picture of ocean health and then find targeted ways to improve it.

Biography

Cyrill Gutsch is an award-winning designer and brand and product developer. In 2012, a meeting with activist Captain Paul Watson, founder of Sea Shepherd Conservation Society and co-founder of Greenpeace, convinced Gutsch to take on the most challenging client, the world's oceans, with the particular objective of focusing attention on the multiple threats facing this vital ecosystem and on establishing a new business culture where it is more lucrative to protect the oceans than to destroy them. Cyrill then founded Parley For the Oceans as a collaboration network to unite scientists, artists, major brands and environmentalists for the oceans cause, acting as a mediator translating creative energy and environmental expertise into business strategy.

Cyrill Gutsch
Founder, Parley for the Oceans

Chapter 2

The technologies and new sciences to drive positive change for the planet

Preventing further climate change or even reversing it requires collective action. Private wealth can deploy its capital in climate-friendly investments. But real change depends on different, widespread, more climate-aware behavior.

Individuals, businesses, and financial institutions must follow one of two paths: either we accept a decline in living standards to limit environmentally damaging activities or we use technologies and new sciences to live more efficiently, doing more with fewer resources and even living and working in ways that improve the environment (by capturing carbon or adopting less carbon-intensive diets, for example).

In this section we briefly examine **the overarching technologies and scientific fields that have the greatest chance of influencing behavior and either preventing climate change or reducing greenhouse gas emissions.**

Which technologies and scientific breakthroughs help individuals tackle climate change?

New food technologies can help individuals reduce their climate impact.

Reducing – much faster, much more comprehensively – food waste (which, if it were a country, would be the third-largest GHG emitter after the US and China according to the UN FAO) depends on increasing the use of robotics and sensors in kitchens, of Big Data in processing inventory data management, and of blockchain in handling food waste data securely.

Wider adoption of plant-based diets and alternative protein sources could also contribute to lower emissions and a healthier planet. A recent UBS CIO report – "The Food Revolution" – found that plant-based meats produce up to 90% less greenhouse gas than beef, require 95% less land, and use up to 99% less water.

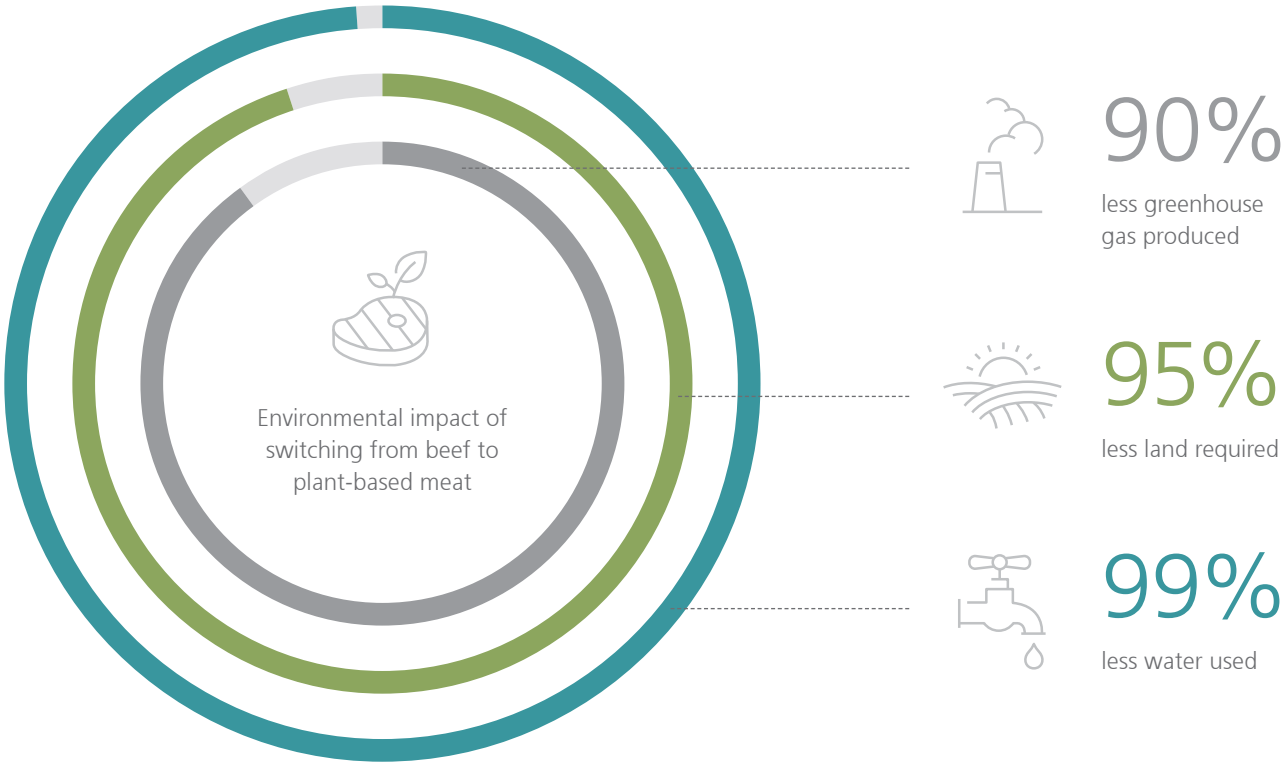
For more details please see UBS's CIO report, **"The Food Revolution."**

Which technologies and scientific breakthroughs help businesses tackle climate change?

Satellite and sensor technology can enable companies to better measure a project's environmental impact. This should enable resources and capital to be allocated to the most profitable and least polluting opportunities.

Better measurement of the asset price implications of climate change provides more information to corporate decision makers on how to adapt business models to protect against risks or capitalize on related opportunities, using new technologies or scientific methods.

For example, gene-editing technologies can create new plant varieties that require fewer fertilizer applications, or vaccines that suppress methane-producing microbes. Lower chemical use would in turn reduce chemical runoff into oceans, a major store of carbon and a rich source of biodiversity.



Source: Beyond Meat's Beyond Burger Life Cycle Assessment, September 2012, Food policy, December 2012, LCA Update, 2019, Value of water research report series no. 48, 2010

Which technologies help financial institutions support policymakers, consumers, and corporates to tackle climate change?

Greater availability of data and advances in machine learning and AI are assisting financial institutions in modeling the potential financial impact of climate change (on specific assets and multi-asset portfolios). This enhances the understanding investors have of their climate risk exposure, and enables them to identify assets that meet their financial and environmental objectives.

Financial institutions can direct institutional and private investment either into assets more resilient to the effects of climate change or into technologies that combat it. Several financial data providers are currently building or buying climate risk models and assimilating them into their portfolio management process.

Last, financial institutions can devise innovative financing models that steer client money to promising new client-friendly corporate projects and cutting-edge startups.

Endnotes

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