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Q&A With Azeem Azhar on Climate Change

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At Global X ETFs, we believe a chart is worth a thousand words, and then some, when it comes to our changing world. **Charting Disruption**, our annual thematic research project, depicts the disruptive themes changing our world through charts, graphics, and much more. While the topics of the four main sections, including Personalised Medicine, A Greener Economy, Experiential Technologies, and FinTech, Blockchain, & Web3 are each unique, they are connected by innovation and the ability to transform the world.

To explore the depth of these changes, Global X ETFs' Research Team partnered with handpicked experts from academia, consulting, and investing. Below, we discuss the state of climate change as well as some of the most promising mitigation and adaptation solutions with Azeem Azhar. Azeem is an award-winning entrepreneur, analyst, strategist, and investor. He produces "Exponential View," a leading newsletter and podcast on the impact of technology and our future economy.

The planet's imperilled health creates an urgent need for a Greener Economy. Human activity created the climate crisis, but human innovation can solve it with economy-changing solutions that promote decarbonisation.

1. What does the world need to do to mitigate climate change?

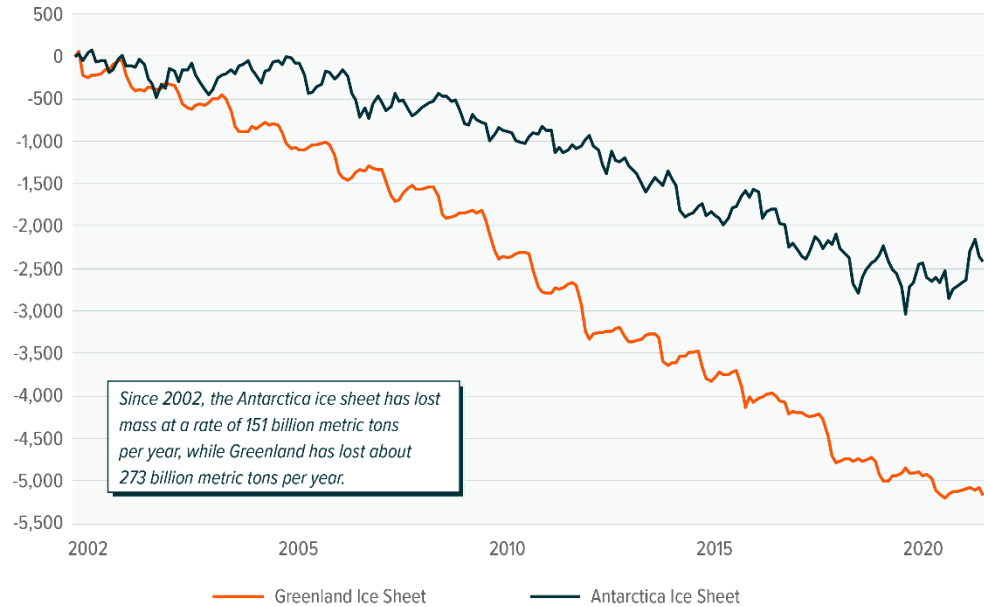
The Intergovernmental Panel on Climate Change (IPCC) reports that the world is not on a path to limit temperature rises to 1.5°C.¹ The science suggests that a rapid progression of temperature rises is likely to trigger significant climate feedback loops that result in dramatic effects and runaway processes, such as the melting of glaciers and ice sheets. Therefore, mitigating the impact of climate change by decarbonising our economies through behaviour change, technology, and nature-based solutions is essential. Taking a sanguine view on the adaptations that climate change might require is also vital.

Climate change requires a restructuring of the global economy that meets the needs of the biosphere that supports us. To maintain prosperity levels in richer countries and allow people in poorer countries to live more prosperous and healthier lives, ensuring economic activity is crucial. And the only way we can hope to meet these goals within the limits of the biosphere is through behaviour change, new approaches to economic activity, and investments in enabling technologies. For innovators, this action plan is a huge opportunity to be a part of the solution.



ICE MASS VARIATION SINCE 2002 (GIGATONS)

Sources: Global X ETFs with information derived from: Nasa. (2022). Ice sheets. Nasa: Global Climate Change, Vital Signs of the Planet. Accessed on December 5, 2022.



2. From an investor perspective, how can government actions, such as the Inflation Reduction Act in the U.S. and green funding in the EU, play a role in accelerating the adoption of climate change technology?

These government actions should speed up the development and deployment of climate change mitigation and adaptation technologies. They will also create demand for climate change solutions that give businesses certainty that such markets will exist, and in the process, incentivise investment. As many of these technologies benefit from the experience curve, where increasing demand results in lower prices, earlier investments compound in terms of more rapid price declines.

This dynamic can give entrepreneurs and the capital that backs them additional confidence. In good economic times, this can be a boon, where the government is an investor or buyer of first resort and can help difficult technologies break into the market. Consider the U.S. government's interventions in the RNA platform a decade ago or in enabling the GPS system. But during turbulent economic times, the visibility offered by the strong direction setting and funding from governments is not merely a bonus but essential.

I call this type of activist policy "catalytic government" because so far, with few exceptions, governments act at a sectoral or behavioural level rather than favour specific technologies or firms. This approach should be effective because it provides markets with the signals that they require to act without telling them what to do. Catalytic government is far removed from the laissez-faire approaches preferred since the 1980s.

3. Whether out of a sense of altruism or self-preservation, many companies are making significant commitments to reduce their carbon footprints. To what



extent could investments from the private sector serve as an engine for innovation and growth of clean technologies such as renewable energy?

The private sector can unleash a flywheel of innovation. Upfront commitments to move to renewables and buy carbon removals create financial incentives for firms to invest in providing these services. As more companies pile in, competition and learning drives down prices, which in turn brings in more customers. Moribund markets where products are expensive for want of innovation can be given life if this flywheel spins.

Also, the power that large tech firms have over the supply chains should not be underestimated. Apple, for example, signalled its intention to turn its supply chain carbon neutral by eliminating Scope 3 emissions.² Not produced by the company, these emissions are indirect, produced by suppliers that make products that the company uses. Scope 3 emissions also include emissions produced by customers using their products. For hundreds of suppliers, Apple's transition could mean that they become carbon neutral or lose Apple's business. A powerful ecosystem effect like this can make those suppliers more desirable partners to other original equipment manufacturers (OEMs).

4. How can the world reach net zero emissions by 2050? What opportunities can this green transition create for companies throughout the value chains of vital clean technologies such as renewable energy, green hydrogen, and electric vehicles?

We get to net zero emissions globally by vastly increasing the amount of low-carbon electricity we generate, primarily through solar, but also with other renewable and clean energy sources like wind, hydropower, and nuclear. We need excess electricity because net zero requires switching the energy system *in toto*.

This transition includes using electricity for all the expensive-to-abate activities that rely on fossil fuels, such as industrial processes, heating, and truck, marine and aviation transportation. We'll use electricity directly via battery-powered buses and heat pumps, and indirectly via zero-carbon intermediates like the hydrogen used in steelmaking and synthetic fuels for transport. We'll also use electricity to power direct air capture technologies to remove the atmospheric carbon dioxide that we are unable to absorb through nature-based sinks.

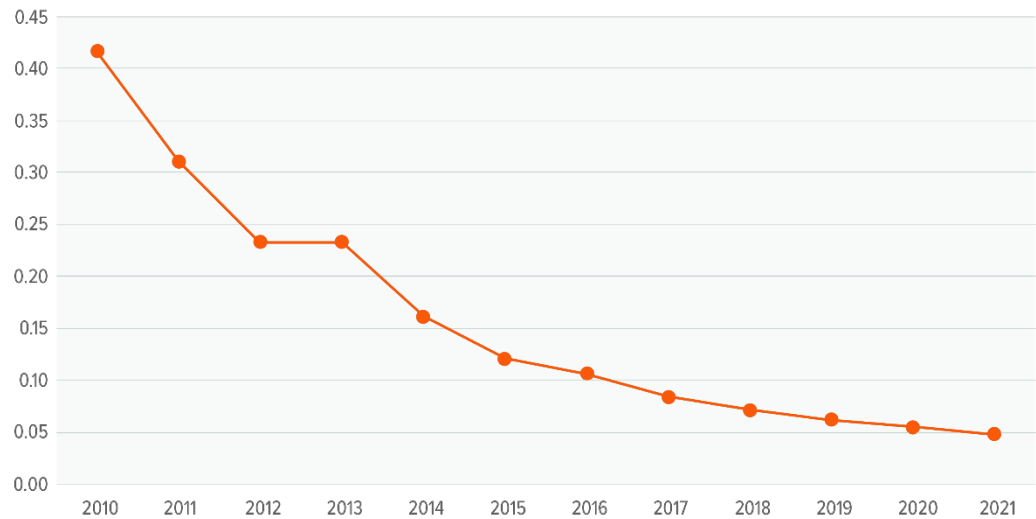
The key will be to drive down the cost of renewable electricity and the batteries and electrolyzers needed for various chemical processes. The learning rates of these technologies, that is, the way prices fall with cumulative installed capacity, are significant, so we can look forward to huge cost declines in each of these areas. Lower costs make these foundations of the green transition not merely economically viable, but also economically more attractive than maintaining a hydrocarbon economy.

Costs are already coming down. According to the National Renewable Energy Laboratory, in the decade after 2010, the cost of utility-scale solar power installations declined by 82%.³ This was reflected in the price of electricity generated by utility-scale solar, which fell 85% over the same time period according to IRENA.⁴ Lithium-ion battery prices dropped 98% between 1990 and 2018, with further declines since.⁵ The renewable electricity grid will look more like the internet than the traditional power grid, in that it will be distributed more broadly, bi-directional, and, of course, digital. Regional, city and more local microgrids will emerge, creating localised markets and firms that operate in those markets.



AVERAGE SOLAR PHOTOVOLTAIC COST BY YEAR (USD/KWH)

Sources: Global X ETFs with information derived from: International Renewable Energy Agency (IRENA). (2022, July 13).
Infographic: Competitiveness of renewables continued amid fossil fuel crisis.



Clean energy is just one important part of the solution, as our modern economies rely on massive material inputs. For example, the global economy chews through nearly 2 billion tons of steel and hundreds of billions of gallons of hydrocarbons for fuel, lubricants, and feedstocks for plastics each year.^{6,7} A ton of innovation will need to scale technologies to decarbonise these systems. Companies like H2 Green Steel and Electra seek to eliminate carbon emissions from steel making, while Lanza Tech aims to produce carbon-neutral jet fuels. In addition, the market for carbon capture and storage (CCS) is poised to grow substantially. In 2021, artificial CCS approached 40 megatons, but the scale of opportunity is measured in gigatons.⁸ Each of those innovations will create new markets, and within them new opportunities for entrepreneurs.

5. Increasing food and water shortages are a likely outcome of climate change. Importantly, we’re starting to see new AgTech solutions such as precision agriculture and controlled environments leverage data and AI to minimise agriculture inputs and maximise yields. What are some success stories, and what factors could lead to further adoption?

Vertical farming, or controlled environment agriculture, is rather remarkable. It uses far less water and other resources, and it delivers more nutritious food than big agriculture. Investments in machine learning, robotics, and automation mean that vertical farms, like 80 Acres Farms and Infarm, go through multiple growing cycles each year. That velocity allows for more iteration and learning, further driving down costs. The modular product-oriented approach of vertical farming also means scaling is more predictable than traditional field-based agriculture. Farmers know the costs of each vertical farm and its precise output, which results in much less risky investment decisions.

Of course, vertical farms remain few and far between, and they do not yet tackle the cereals sector, which comprises about a fifth of human calorie intake and 700 million hectares of land globally.^{9,10} Some research suggests that vertical farming of wheat could achieve yields hundreds of times higher than open-field farming, but the scale means more effective farming methods are needed.¹¹

With more advanced sensors connected through a panoply of communications networks, from low-power wireless to satellite internet, farmers will be able to get a detailed understanding of their crops and



make precise interventions. The use of sensor technology could result in higher yield, lower wastage, and lower spending on fertilisers and pesticides. Access to knowledge, technical expertise, capital, and infrastructure, especially in poor regions, will be key to enabling this shift.

Footnotes

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