



# CLIMATE CHANGE (CLEAN ENERGY & RESOURCE SCARCITY)

Climate change threatens every walk of life, jeopardizing clean air, safe drinking water, sufficient food, and secure shelter.<sup>1</sup> It is also responsible for an acceleration of the melting of polar ice caps, longer and more severe wildfire seasons and more forceful hurricanes which threaten these basic human needs. To avert the worst impacts of climate change and preserve a livable planet, global temperature increases must be limited to 1.5°C, which requires the world to reduce greenhouse gas emissions 45% by 2030 and achieve net zero by 2050.<sup>2</sup> Reaching these ambitious targets, is a massive undertaking that requires the adoption of green technology and renewable energy, both of which require massive, recurrent investment.

## KEY TAKEAWAYS

- The Russia-Ukraine War will likely accelerate the transition to clean energy as Europe moves toward energy independence from Russian fossil fuels, which now represent a threat to national security.
- Global investment in clean energy is far below where it needs to be for the world to reach net zero greenhouse gas emissions (GHG) by 2050. Annual investment in clean energy projects and infrastructure for the rest of this decade must increase from \$750 billion in 2021 to over \$4 trillion, well above the \$2.3 trillion that is expected.<sup>3</sup>
- The Physical Environment mega theme affects all other themes. We highlight the theme’s intersection with and potential investment opportunities across the Disruptive Materials and the Mobility mega themes and their associated themes, such as Electronic and Autonomous Vehicles (EVs/AVs). These technologies are core to combatting the negative impacts of climate change.

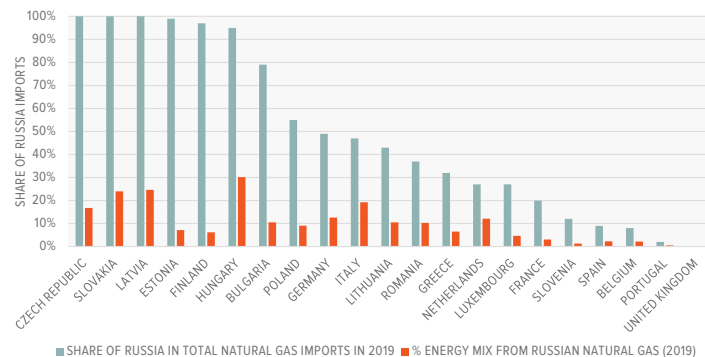
## WHY CLIMATE CHANGE IS SUCH A POWERFUL FORCE

*Geopolitical factors can accelerate the opportunity for the clean energy and AgTech markets.*

Russia’s invasion of Ukraine brought to light the role geopolitics can play in addressing climate change. The war served as a reminder that transitioning to renewable energy is not only good for the climate, but also for national security. For example, relying on authoritarian regimes for something as crucial as energy carries significant risk. In 2021, the European Union (EU) imported roughly 40% of its gas and 25% of its oil from Russia. In response to the war, the EU now plans to reduce Russian gas imports by two-thirds by the end of the year, and to eliminate them altogether by 2030. Global energy prices, which were already high before the war due to pandemic-related supply and demand issues, skyrocketed following the invasion.<sup>4</sup>

## RUSSIA GAS IMPORTS IN EUROPE

Source: Statista & IEA data as of July 11, 2022



The geopolitical and price pressures stoked by the war will likely accelerate the transition away from oil, gas, and coal. The White House said that greater energy efficiency can be immediately achieved by increasing the use of smart thermostats and heat pumps.<sup>5</sup> The EU said that energy conservation actions by its citizens could save enough oil to fill 120 super tankers and enough natural gas to heat almost 20 million homes.<sup>6</sup>

The agricultural market is also in the war’s crosshairs with food production reduced and supply disruptions expected to keep agriculture prices elevated.<sup>7</sup> Combined, Russia and Ukraine are responsible for about 25% of the world’s wheat exports, 65% of its sunflower oil exports, 20% of barley exports, and 18% of corn exports.<sup>8</sup> Also, Western sanctions on Russia are expected to continue to affect the fertilizer supply, given that Russia is the world’s largest fertilizer exporter.

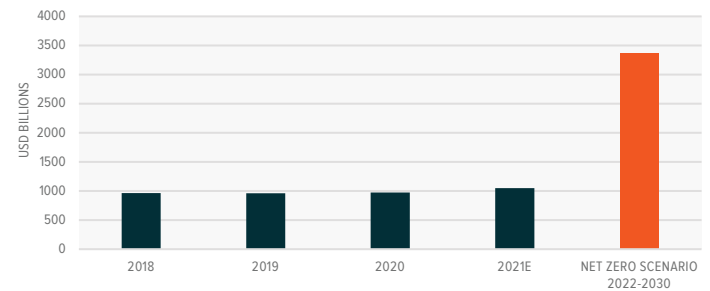
AgTech can help stave off long-term food insecurity and counter geopolitical consequences. This market is expected to grow from \$20B in 2022 to over \$40B in 2030.<sup>9</sup> Precision agriculture and agricultural robots are two examples in which improve efficiencies in the agricultural market by reducing the use of traditional inputs. AgTech could facilitate more intelligent decisions about how to protect the world’s dwindling resources, which ultimately could mean feeding millions more people. The war exacerbated a vulnerable food system that was already experiencing the impact of labor shortages, increasing input costs and supply chain disruptions. However, it is evident that AgTech will likely continue to play a larger and more vital part in the food system of the future.

*Investments in green technology and renewables must increase significantly to reach net zero by 2050.*

The global economy is expected to be nearly 40% larger in 2030 than it is today, but the International Energy Agency (IEA) estimates that it needs to use 7% less energy to meet net zero emissions by 2050. This target requires a major push to increase energy efficiency. The annual rate of energy improvements must average 4% to 2030.<sup>10</sup> However, global investment in clean energy projects and infrastructure is far below where it needs to be. To close the gap, annual investment for the rest of this decade needs to be three times higher than it was in 2021, as the chart below illustrates.<sup>11</sup>

## CLEAN ENERGY & INFRASTRUCTURE INVESTMENT 2018-2030

Source: IEA data as of October 26, 2022



Last year, the U.S. took a major step in combatting climate change with the passage of the Inflation Reduction Act. The act directs nearly \$370 billion toward bolstering U.S. climate change mitigation and adaption, increasing energy security, and lowering energy costs.<sup>12</sup> This effort along with various other initiatives globally will be essential to put the world on track to hitting net zero targets by 2050. With these measures, economy-wide emissions are forecast to decline 37% to 41% below 2005 levels by 2030.<sup>13</sup> Without it, U.S. emissions were forecast to fall well short of the goal, declining just 24% by 2030.<sup>14</sup>



Renewable energy use is central to meeting net zero targets. Two-thirds of the total energy supply in 2050 is expected to come from wind, solar, bioenergy, geothermal and hydro energy. Solar energy is expected to be the largest segment and accounts for a fifth of all energy.<sup>15</sup> For perspective on the growth required, in 2021, about 61% of the electricity generated in the U.S. was from fossil fuels, about 19% was from nuclear energy, and 20% came from renewable sources. Wind and hydropower were the largest renewable sources at 9.5% and 6.3%, respectively.<sup>16</sup>

Globally, progress is slightly better, as renewables comprised 29% of electricity generation in 2020, much of it from hydropower. However, despite the significant growth of renewable energy over the last decade, the global rate of renewable energy generation will need to double in order to hit net zero.

*The acceleration to net-zero can create opportunities in areas of scarcity.*

The world's push for net zero will put numerous resources in high demand, likely leading to shortages. For example, food systems currently generate about one-third of GHG emissions to feed roughly 8 billion people. But by 2050, the world will need to feed up to 10 billion people while producing significantly less emissions.<sup>17</sup> With climate change, loss of farmland, loss of habitats, and freshwater depletion and pollution are longer-term, existential risks to humanity's food supply. Currently, only 15 crop types and five livestock species provide about 80% of our global food supply. To survive, the world must adapt, with technology like precision agriculture, agriculture robots (AgRobots), and controlled environment agriculture (CEA) playing a central role.<sup>18</sup>

Also intertwined with food scarcity is the lack of clean water. Currently, 1 in 10 people lack access to a basic drinking water service, and 1 in 4 people have no access to basic sanitation/ toilets. As 2050 approaches, demand for water is set to increase 20–30%, driven by megatrends including population growth, urbanization, and industrialization, compounded by increases in food and energy demand. Additionally, degradation of water sources is a growing risk with 80% of wastewater currently released untreated. For example, 40% of Beijing's water sources is "unfit for human contact."<sup>19</sup>

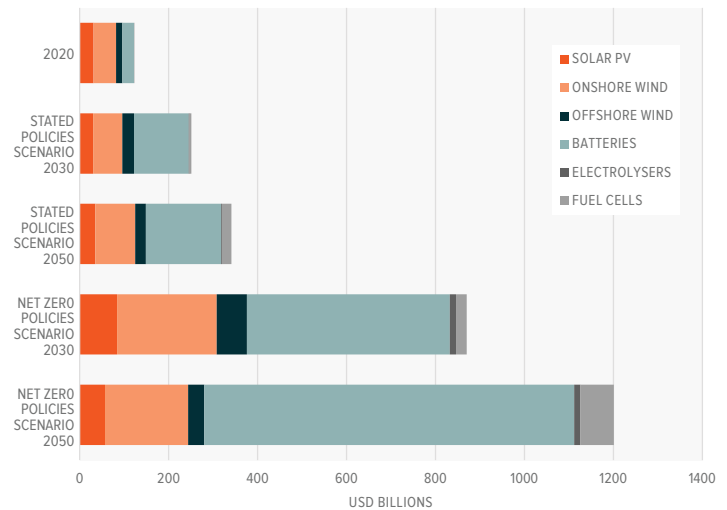
Resource scarcity will also impact the materials needed to produce the technologies required for greener solutions. According to the IEA's Net Zero by 2050 Scenario, the accelerated transition from fossil fuel to clean energy sources could increase mineral demand by six times between 2020 and 2050. The majority of the increase in volume is attributable to electric vehicles and battery storage. Since 2015, EVs and battery storage have surpassed consumer electronics to become the largest consumers of lithium, together accounting for 30% of total current demand. This demand is expected to accelerate as the need for stronger batteries is expected. Recently the IEA estimated that battery demand from EVs will be 40 times greater by 2040 compared to 2020. Demand for nickel, cobalt, and other rare earths are expected to increase significantly relative to what is mined today. A related concern is that China controls 90% of rare earth mineral processing, which could lead to a climate trade war.<sup>20</sup> As countries step up their climate action goals, clean energy technologies are set to become the fastest-growing segment of demand for most minerals. Their share of total demand edges up to over 40% for copper and rare earth elements, 60-70% for nickel and cobalt and almost 90% for lithium by 2040.<sup>21</sup>

## VISUALIZING THE MARKET OPPORTUNITY

The path to net zero emissions requires annual investment in clean energy to rise to \$4 trillion by 2030, triple current levels. Such investment would create opportunities for equipment manufacturers, service providers, developers and engineering, procurement, and construction companies along with the entire clean energy supply chain. For perspective, the combined market opportunity for wind turbines, solar panels, lithium-ion batteries, electrolyser, and fuel cells is an estimated \$27 trillion. In this scenario, EV batteries comprise over 60% of the opportunity.

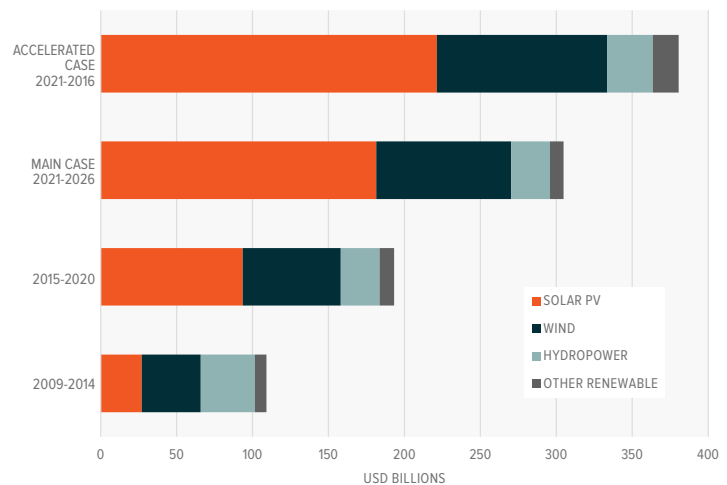
### ESTIMATED MARKET SIZES FOR SELECTED CLEAN ENERGY TECHNOLOGIES BY TECHNOLOGY & REGIONS

Source: IEA data as of October 26, 2022



### RENEWABLE ELECTRICITY CAPACITY GROWTH BY TECHNOLOGY

Source: IEA data as of November 30, 2021



Solar photovoltaic (PV) is the growth powerhouse in renewable electricity, with its capacity additions forecasted to increase by 17% in 2021 to a new record of almost 160 gigawatts (GW). Total offshore wind capacity is forecasted to more than triple by 2026.<sup>22</sup>



## RISKS TO THE CLIMATE CHANGE THEME

*Cost pressures may impact the adoption of renewable energy sources.*

With improvements in technology, renewable energy sources are now cost-competitive with oil, coal, and gas-fired power. Utility-scale solar PV costs are 85% lower than in 2010, and onshore and offshore wind power are 48% and 68% lower, respectively.<sup>23</sup>

However, to build the infrastructure to facilitate the transition also requires significant expenditure. For the U.S. to reach 100% renewable energy by 2050 requires a \$7.8 trillion investment. Among other infrastructure, the U.S. must build 288,000 new 5-megawatt (MW) wind turbines and 16,000 100-MW solar farms on 1.08% of U.S. land, a meaningful percentage. The decarbonization plan would also reduce energy costs by \$1.3 trillion per year, because renewable energy is cheaper to generate over time than fossil fuels. In addition, the plan would cut health and climate costs by \$700 billion and \$3.1 trillion annually, respectively, compared to current fossil fuel infrastructure.<sup>24</sup>

Economic recovery from the pandemic complicates the transition. Pandemic-induced supply chain bottlenecks put significant pressure on prices, and the war in Ukraine added pressure. Demand for sustainable sources such as wind and solar now significantly outpace supply.<sup>25</sup> Post-invasion, renewable energy projects face soaring prices for key materials such as aluminum and steel, as well as higher transportation costs owing to oil prices surging by more than 50% this year. Also, in almost every competitive power market in the U.S., long-term contracts for wind and solar-power purchases, which are used to finance new projects, are substantially higher.<sup>26</sup>

In the near term, cost pressures like these can cause a hiccup in renewable energy production. However, we believe that the war brought the importance of long-term energy security to the forefront on individual country and global levels. With increased recognition that renewable energy sources are effective solutions, we expect them to accelerate the energy transition.

*Emerging markets and developing economies make up a large part of underfunding.*

An estimated 70% of the additional investment in clean energy required to hit the \$4 trillion target by 2030 must come from emerging market and developing economies. Notable examples of developing economies mobilizing capital for clean energy projects include India's success in financing a rapid expansion of solar photovoltaic (PV) in pursuit of its 450 GW target for renewables by 2030.<sup>27</sup>

However, funds to support sustainable economic recovery for developing nations from COVID-19 are scarce. Also, financing capital remains up to seven times more expensive than in advanced economies.<sup>28</sup> The pandemic broke the trend of steady progress towards universal access to electricity and clean cooking.<sup>29</sup> In Africa, the number of people without electricity increased in 2020 after declining over the previous six years. In developing African and Asian countries, basic electricity services are now unaffordable for more than 25 million people due to population growth and increasing levels of poverty. An additional 85 million people, mainly

in developing Asia, may be forced to scale back to basic electricity access because of an inability to pay for an extended bundle of services.<sup>30</sup>

It is essential to accelerate funding from international sources to allow developing economies to chart a new lower emissions path. Alongside the necessary policy and regulatory reforms, public financial institutions – led by international development banks and larger climate finance commitments from advanced economies – play crucial roles to bring forward investment in areas where private players do not yet see the right balance of risk and reward. We expect climate concerns to continue to play a large role within global policies and the affects will have to trickle down to developing nations if we are going to strive for global net-zero emissions.

## THEMATIC INTERSECTION WITH CLIMATE CHANGE

### Disruptive Materials

Disruptive materials are vital to the world's efforts to address climate change. These metals, minerals, and elements provide the backbone to the various game-changing climate technologies. Demand is expected to increase 2–6x from today, depending on the level of climate change adaptation achieved. The low end considers a conservative scenario where adaptation does not go significantly beyond current policy, while the high end assumes net zero is hit by 2050.<sup>31</sup>

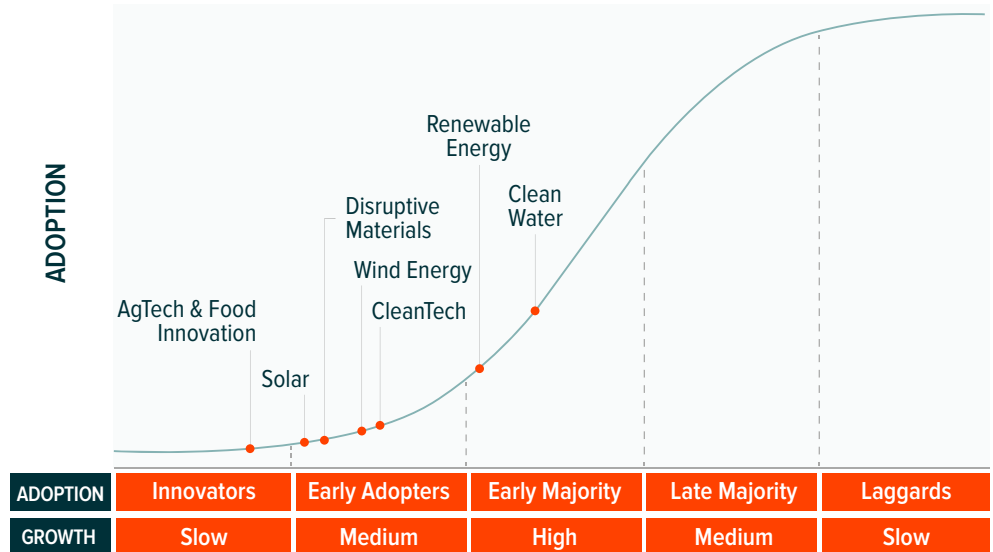
[Global X Research](#) expects the transition from internal combustion engine (ICE) vehicles to EVs to be a significant driver of demand for materials like lithium, graphite, copper, nickel, cobalt, and manganese. For example, an EV requires six times more of these materials than a transitional ICE. Elsewhere, the growth of renewable energy sources like wind and solar will rely heavily on disruptive materials. Solar power generation requires about 5 kilograms (KG) of copper per kilowatt (KW), roughly twice that of conventional power generation.

### Mobility

Mobility continues to become cleaner, smarter, and more autonomous as the world tries to mitigate climate change. In 2021, 6.5 million electric vehicles were sold worldwide, up 109% on 2020. EV sales accounted for 9% of all passenger vehicles sold. Nearly 85% of the EVs sold were to customers in Mainland China and Europe.<sup>32</sup>

## THEMATIC ADOPTION

Source: EM Rogers, "Diffusion of Innovations", 1962, and Global X Research, 2021.





Demand continues to increase. A recent survey revealed that 7 out of 10 U.S. drivers would be interested in buying an EV when charging infrastructure expands and EV costs drop.<sup>33</sup> To meet this demand, one estimate says automakers and suppliers need to invest at least \$526 billion in EVs and batteries between 2022 and 2026, more than double the five-year EV investment forecast of \$234 billion for 2020–2024.<sup>34</sup> Net zero by 2050 requires global EV sales to increase to 60% of total car sales by 2030.<sup>35</sup>

**CLIMATE CHANGE IN A PORTFOLIO CONTEXT**

It is always important to look to tailwinds. The Inflation Reduction Act recently signed into law will provide much needed funding to assist in meeting climate action targets. We expect the Climate Change theme to become increasingly prominent in investment portfolios. Given the scope and magnitude of the crisis, the Climate Change theme is diverse, spanning numerous sectors and specializations. On the adoption curve, Clean Water and Renewable Energy are in the Early Majority phase, indicating adoption levels are high and rising. CleanTech, Solar, Disruptive Materials, and Wind are in the Early Adoption phase. As countries prioritize clean energy and energy security, we expect their adoption to accelerate. Subsets of the Climate Change theme will continue to accelerate as well.

The pie charts break down the geographic exposure of the largest Climate Change thematic ETF products. We believe that there is ample innovation occurring outside the U.S., and that limiting exposure to the U.S. could exclude key players to the detriment of investors over the long term.

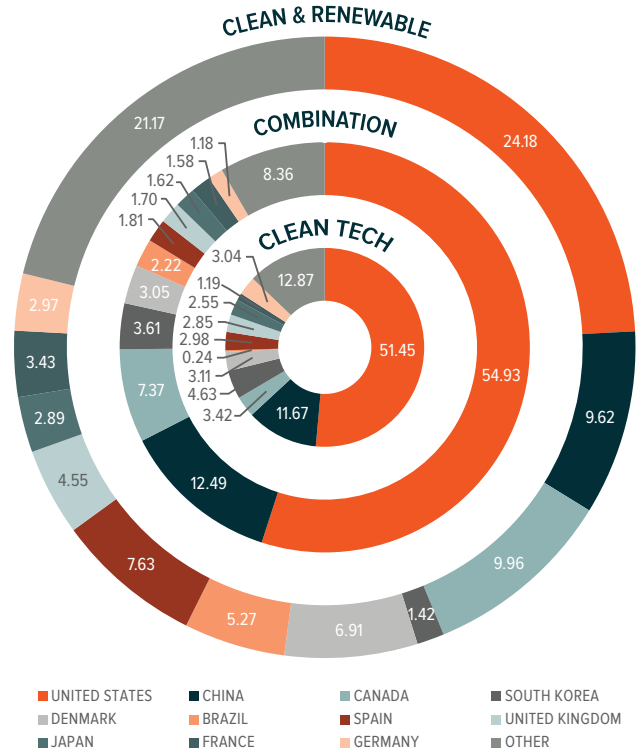
In our view, thematic equity should be targeted, using screens to ensure that the underlying companies provide the desired exposure. This pure play focus minimizes overlap between themes while also differentiating the exposure provided by the theme relative to broad beta products. We conducted an overlap analysis between various Climate Change subthemes ETFs, the S&P 500, MSCI ACWI and the most applicable S&P 500 sector ETFs for each exposure. For the latter, we used the Technology Select Sector SPDR Fund (XLK) and Industrial Select Sector SPDR Fund (XLI) for CleanTech, the Utilities Select Sector SPDR Fund (XLU) for Renewable Energy, and the Materials Select Sector SPDR Fund (XLB) for Disruptive Materials.

We found that average overlap by weight for CleanTech was 1.3% when compared to the S&P 500, 1.2% vs. the MSCI ACWI, 0.6% vs. XLK, and 1.8% vs. XLI.<sup>36</sup> Similarly, the overlap for Renewable Energy was a low 0.05% when compared to the S&P 500, 0.15% vs. the MSCI ACWI, and 0.0% vs. XLU.<sup>37</sup> The overlap for Disruptive Materials was 0.1% compared to the S&P 500, 0.2% vs. the MSCI ACWI, and 5.4% vs. XLB.<sup>38</sup> The low overlap with broad indexes reflects the benefits of thematic exposure, as sector indexes have yet to include substantial exposures towards these Climate Change themes.

Climate change affects the most critical aspects of life, including food, shelter, safety, and work. Many communities are already experiencing the negative impacts, especially those that are more vulnerable. With the repercussions becoming more acute, we expect progress toward net zero to create opportunities across themes like Clean & Renewable Energy and Disruptive Materials. Many climate change-related themes are in the earlier phases on the adoption curve; however, we expect their adoption and growth to accelerate as public and private sector investment ramps up. Climate change requires significant capital expenditure, but inaction will be vastly more expensive.

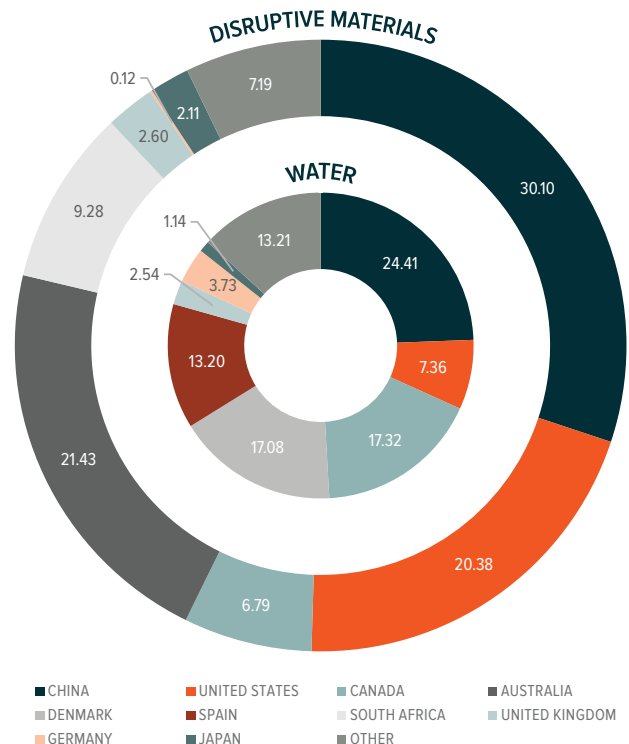
**CLEAN ENERGY: AVERAGE GEOGRAPHIC EXPOSURE BY THEME**

Source: Morningstar data as of June 30, 2022



**RESOURCE SCARCITY: AVERAGE GEOGRAPHIC EXPOSURE BY THEME**

Source: Morningstar data as of June 30, 2022

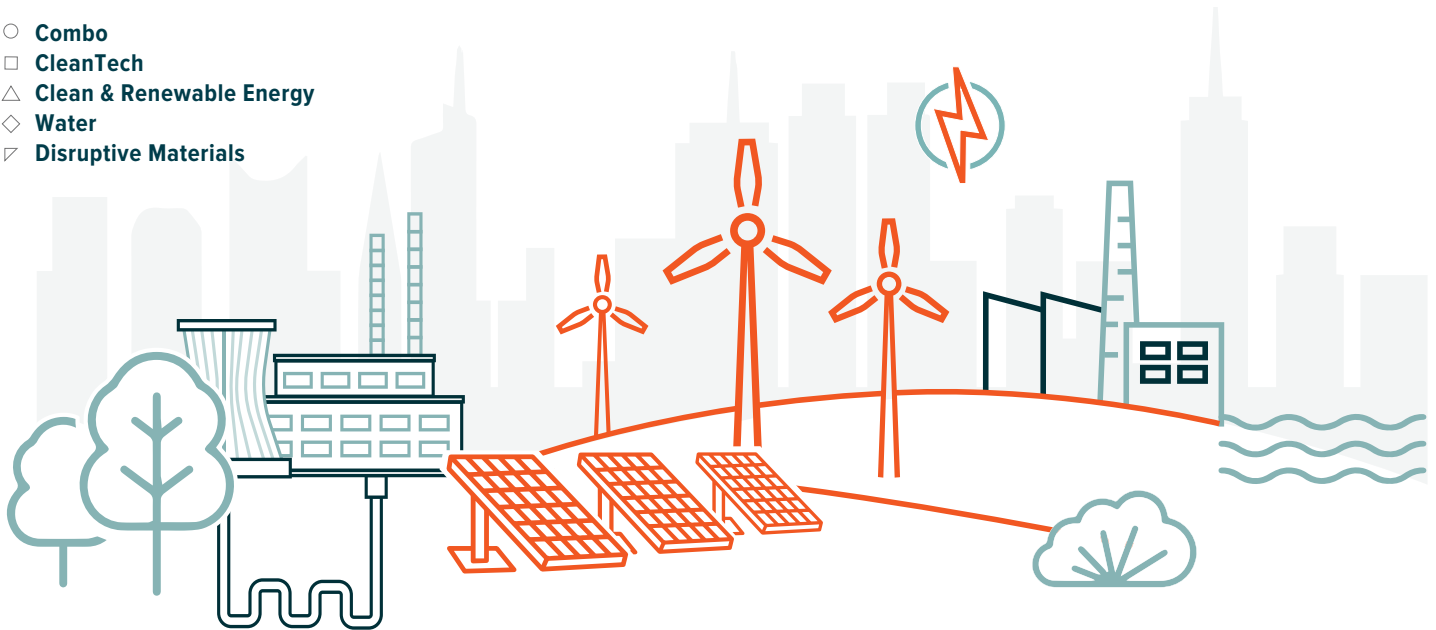




## HOW TO ACCESS CLIMATE CHANGE

The graphic below identifies the largest U.S. listed ETFs that provide direct exposure to the Climate Change theme through Clean Energy and Resource Scarcity.

- Combo
- CleanTech
- △ Clean & Renewable Energy
- ◇ Water
- ▽ Disruptive Materials



### CLEAN ENERGY

- **ICLN**  
iShares Global Clean Energy ETF
- **ACES**  
ALPS Clean Energy ETF
- **CNRG**  
SPDR S&P Kensho Clean Power ETF
- **GCLN**  
Goldman Sachs Bloomberg Clean Energy Equity ETF
- **BNE**  
Blue Horizon BNE ETF
- **QCLN**  
First Trust NASDAQ Clean Edge Green Energy Idx Fd
- **PBW**  
Invesco WilderHill Clean Energy ETF
- **PBD**  
Invesco Global Clean Energy ETF
- **GSFP**  
Goldman Sachs Future Planet Equity ETF
- **CTEC**  
Global X CleanTech ETF
- △ **RNRG**  
Global X Renewable Energy Producers ETF
- △ **FRNW**  
Fidelity Clean Energy ETF

### RESOURCE SCARCITY

- ◇ **PHO**  
Invesco Water Resources ETF
- ◇ **FIW**  
First Trust Water ETF
- ◇ **CGW**  
Invesco S&P Global Water Index ETF
- ▽ **REMX**  
VanEck Rare Earth/Strategic Metals ETF
- ▽ **DMAT**  
Global X Disruptive Materials ETF
- ▽ **CRIT**  
Optica Rare Earths & Critical Materials ETF



## CLIMATE CHANGE FOOTNOTES

- <sup>1</sup> WHO, Climate change and health, July 2022.
- <sup>2</sup> NASA, The Effects of Climate Change, July 2022.
- <sup>3</sup> IEA, World Energy Investment 2021, September 2022.
- <sup>4</sup> AP News, War shakes Europe path to energy independence, climate goals, July 2022. & World Economic Forum, How much energy does EU import from Russia?, July 2022.
- <sup>5</sup> The White House, FACT SHEET: Unites States and European Commission Announce Task Force to Reduce Europe's Dependence on Russian Fossil Fuels, July 2022.
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- <sup>7</sup> BofA Global Research, Food security: environmental meets social, July 2022.
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- <sup>9</sup> Exploding Topics, Global AgTech Market Size, Growth, & Trends (2022-2030), August 2022.
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- <sup>11</sup> IEA, Clean Energy and Infrastructure investment, 2018-2030, July 2022.
- <sup>12</sup> The White House, By the Numbers: The Inflation Reduction Act, August 2022.
- <sup>13</sup> Energy Innovation, Modeling the Inflation Reduction Act using the Energy Policy Simulator, August 2022.
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- <sup>20</sup> Bank of America Institute, Resource Scarcity, Addressing Scarcity in a Transforming World, July 2022.
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- <sup>22</sup> IEA, Renewable electricity growth is accelerating faster than ever worldwide, supporting the emergence of the new global energy economy, July 2022.
- <sup>23</sup> Irena, Renewable Power Generation Costs in 2020, September 2022.
- <sup>24</sup> Yale Environment 360, The Global Price Tag for 100 Percent Renewable Energy: \$73 Trillion, December 2019
- <sup>25</sup> The New York Times, Will War Make Europe's Switch to Clean Energy Even Harder?, July 2022.
- <sup>26</sup> WSJ, Ukraine War Drives Up Cost of Wind, Solar Power, July 2022.
- <sup>27</sup> IEA, World Energy Outlook 2021, July 2022
- <sup>28</sup> Brookings, Bridging the 'great finance divide' in developing countries, June 2022.
- <sup>29</sup> IEA, World Energy Outlook 2021, July 2022
- <sup>30</sup> UN, Ensure access to affordable, reliable, sustainable and modern energy for all, August 2022.
- <sup>31</sup> IEA, The Role of Critical Minerals in Clean Energy Transitions, July 2022.
- <sup>32</sup> Canals, Global electric vehicle sales up 109% in 2021, with half in Mainland China, July 2022.
- <sup>33</sup> Consumer Reports, New Consumer Reports Survey Finds Majority of Drivers are Interested in Electric Vehicles, July 2022.
- <sup>34</sup> Emobility, Electric Vehicle Sales Could Rise To 33% Globally By 2028, Says Report, July 2022.
- <sup>35</sup> IEA, World Energy Outlook 2021, July 2022
- <sup>36</sup> ETF Action data as of September 2, 2022. Overlap data focuses on the largest five U.S. listed ETFs for each the theme.
- <sup>37</sup> ETF Action data as of September 2, 2022. Overlap data focuses on the largest two U.S. listed ETFs for the theme.
- <sup>38</sup> ETF Action data as of September 2, 2022. Overlap data focuses on the largest three U.S. listed ETFs for the theme.

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