GLOBAL X
by Mirae Asset

Thematic Investing in the Sustainable Energy Transition

7 April 2022

Content

About Us

Global X ETFs was founded in 2008. For more than a decade, our mission has been empowering investors with unexplored and intelligent solutions.

Our Team

A diverse collection of more than 80 financial professionals, representing more than five native languages and ten nationalities, bringing together over 200 years of industry experience

Our Business

- Exchanged-Traded Funds (ETFs)
- Research & Insights
- ETF Model Portfolios

Our Partners

- Global Perspective & Reach
- World-renown Index Providers & Exchanges

Our Brand

GLOBAL X by Mirae Asset

Global X Overview: ~$43.6bn in AUM across 90 ETFs

AUM ($mil) by Fund Family as of December 31, 2021

- **Income** — 20 ETFs
- **Thematic Growth** — 33 ETFs
- **International Access** — 22 ETFs
- **Core** — 4 ETFs
- **Other Strategies** — 11 ETFs

Targeting companies that may be poised to benefit from structural shifts in technology, people and demographics, and infrastructure development

Offering solutions for investors seeking to increase or diversify the yield potential of their portfolio

Including targeted sector exposure to China, along with single-country and regional strategies

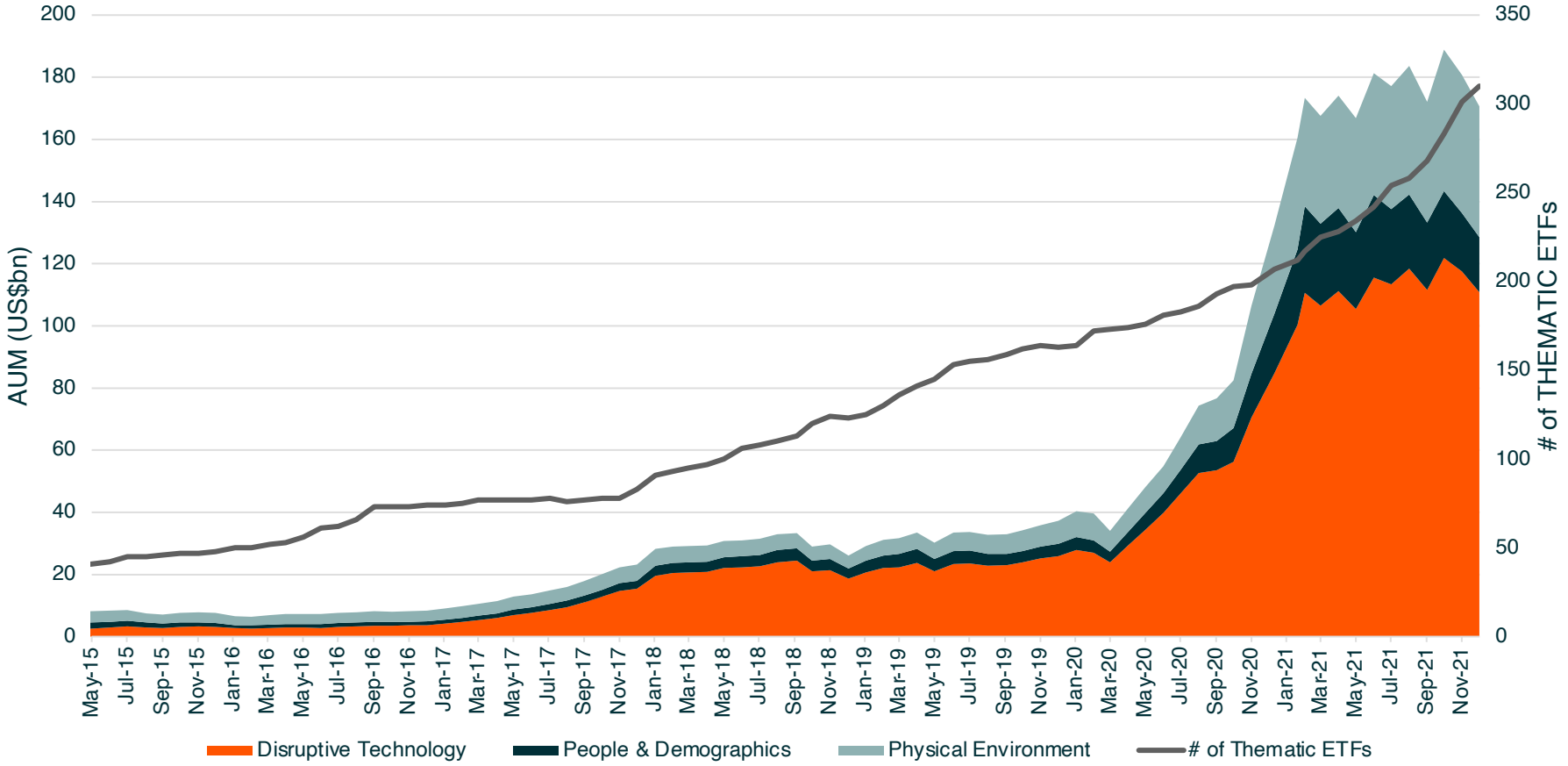
Serving as key portfolio building blocks that seek to deliver exposure to specific factors, values, or geographies

Seeking to align opportunities for exposure to natural resources across a variety of areas, but chiefly in metals, mining, and agriculture

Goal of delivering market-beating total returns by following methodologies backed by academic research

Thematic ETFs Landscape

At the end of December 2021, there were 310 thematic ETFs* totalling US$170.6bn in assets under management, up 29% year-to-date.



Source: Data from Bloomberg as of 31 December 2021. *US thematic ETFs and Europe UCITS ETFs combined

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Thematic Investing

3 Steps for Choosing a Theme

Keys to approaching thematic investing: Look for high conviction themes, investments with high exposure to those themes, and a multi-year time frame.

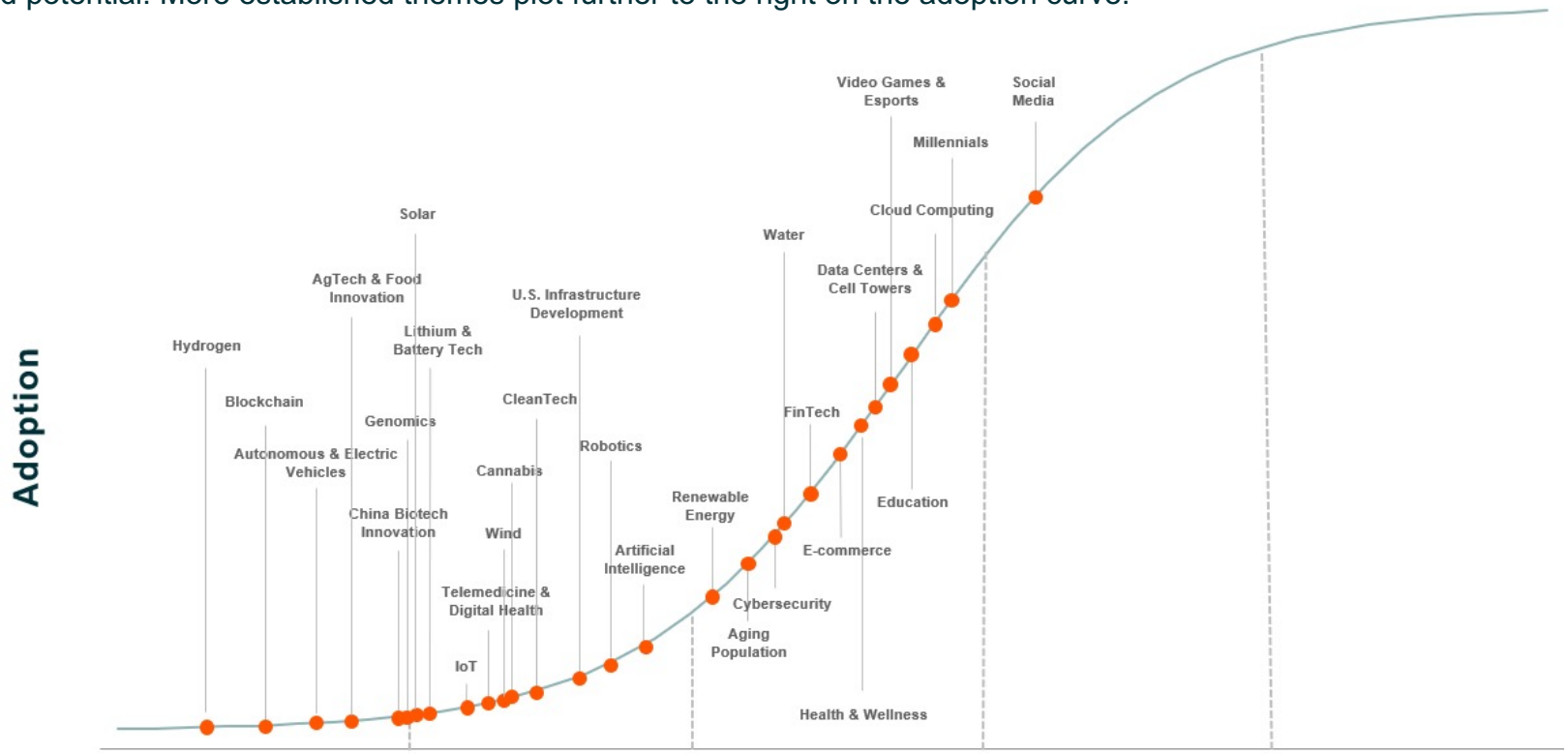
	Stronger Approach	>	Weaker Approach
Conviction	High, due to observable structural changes in demographics, technology, behaviour, or politics/regulations		Limited, due to conjecture and low likelihood of theme materialising
Investability	Broad group of publicly traded companies, with high liquidity, that provide targeted exposure to the theme		Narrow group of companies with low liquidity, and only tangential exposure to the theme
Time Frame	Medium to long term (5 or more years), making market timing less of a factor		Shorter term placing greater importance on timing

Examples of Disruptive Themes

Traditional Sector	Old Paradigm	Sector Disruptor	New Paradigm
Consumer Discretionary	Consumer firms primarily target the spending preferences of baby boomers and Gen Xers, appealing to suburban lifestyles and material wants	Millennials	Millennials are set to see their incomes rise and inherit trillions from the baby boomer generation. Their unique spending preferences, such as living in cities and favoring experiences, are expected to radically alter what types of products are sold and how they are bought.
Energy	The energy sector largely revolves around the extraction and sale of fossil fuels.	Lithium & Battery Tech	Falling costs and rising production of Lithium-ion batteries is leading the shift to renewable energy and electric vehicles.
Financials	Financial firms primarily rely on employee skills to effectively allocate financial capital and provide services to customers.	FinTech	FinTech allows financial firms to leverage cutting edge technology to reduce costs, improve decision making and risk controls, remove middlemen, and enhance customer experiences.
Health Care	Health care systems are designed to treat symptoms or ailments once they occur.	Health & Wellness	Increasing lifespans and rising health care costs are driving people to proactively improve their health, through physical activity, healthy eating, and greater mindfulness of their well-being.
Industrials	Manufacturers provide workers with tools and training to complete tasks in an efficient and consistent manner.	Robotics & AI	Advancements in robotics & AI are making machines smarter and more capable than ever before, allowing robots to take on increasingly sophisticated tasks for faster and more accurate production.
Information Technology	The technology ecosystem largely revolves around computers, servers, and mobile devices communicating with each other.	Internet of Things	Declining chip costs and improving connectivity allows for virtually any object to connect to internet-enabled networks, effectively turning anything into a connected device.
Communication Services	People communicate or consumer information primarily through traditional mediums like phone, TV, or radio.	Social Media	People around the world are communicating and sharing information at a rapidly growing pace via new channels such as mobile video, chat, photos, podcasts, and blogs.

Where Do Disruptive Themes Stand?

While each theme follows a unique adoption curve, the chart below estimates the phase of adoption for several themes we cover. Less developed themes plot further to the left on the adoption curve and have both higher risk and higher reward potential. More established themes plot further to the right on the adoption curve.



Adoption	Innovators	Early Adopters	Early Majority	Late Majority	Laggards
Growth	Slow	Medium	High	Medium	Slow

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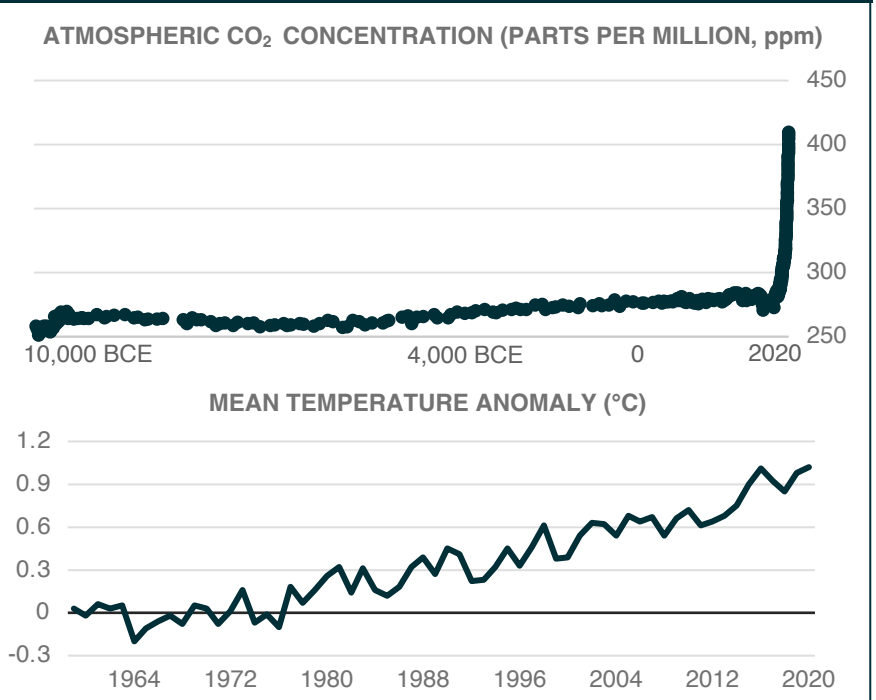
Green Energy Themes

The Need for CleanTech/Renewables: Climate Imperative

The need to address climate change is pressing. Decarbonization through a clean energy transition is our best hope in addressing it.

GLOBAL AVERAGE TEMPERATURES CONTINUE TO TICK UPWARDS AS INTERVENTION BECOMES INCREASINGLY NECESSARY



Note: Temp. anomaly = the change in global surface temperature relative to 1951-1980 averages.
Source: Global X ETFs, NOAA, NASA, October 2020.

Earth's Climate is Changing for the Worse

- **Record Heat:** 2011-2020 avg. temp ~1.1 °C warmer than 1850-1900 average (preindustrial period)[1]
  - 2020 tied 2016 for hottest year & July 2021 = hottest month on record[2,3]
- **Cause:** Atmospheric CO_2 concentration from 2010-2019 was 43% > preindustrial average (410 parts per million vs. 289 ppm)[4]
  - Human activity = primary driver of heightened concentrations
- **Impacts**[5]
  - Intensity/frequency of extreme temps on land increased since the 1950s' & ocean heatwaves doubled since the 1980s
  - Heavy precipitation events are more frequent/intense since 1950s, while droughts also increased from warmer temps.
  - Over past 100 years, sea levels rose faster than in any comparable time-period in 3,000 years prior
- **Current Path:** Under current policies, temperatures in 2100 could fall in the range of 2.1 - 3.9°C > preindustrial averages[6]
- **Solution:** Limiting warming to 1.5°C (critical threshold), by reaching peak emissions by 2020s & reaching net-zero by 2050[7]

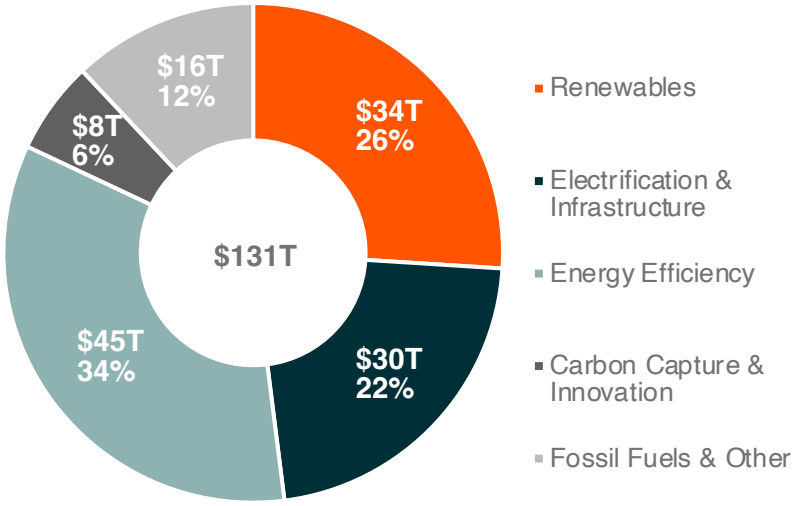
Sources: 1; IPCC, "AR6 - Climate Change 2021: The Physical Science Bias," August 2021.; 2. NASA, "2020 Tied for Warmest Year…," Jan 2021.; 3. Financial Times, "Record June heat in North America…" Jul 2021.; 4. NOAA Global Monitoring Laboratory, Atmospheric Carbon Dioxide Database; Global X Analysis.; 5. IPCC, "Climate Change 2021: The Physical Science Bias," August 2021.; 6. Climate Action Tracker, "Global Update: Climate Summit Momentum," May 2021.; 7. IPCC, "Climate Change 2021: The Physical Science Bias," August 2021.

The Need for CleanTech/Renewables: Addressing Climate Change

Human-emitted Carbon Dioxide (CO_2) is a primary cause of warming. Investment in emissions-reducing clean energy and technologies is essential to achieving carbon neutrality and keeping warming within acceptable levels.

CLIMATE CHANGE MITIGATION EFFORTS WILL REQUIRE SIGNIFICANT INVESTMENT IN CLEANTECH, RENEWABLE CAPACITY

CUMULATIVE INVESTMENT NEEDED BETWEEN 2021 & 2050 ($T)



Note: Investment amounts reflect spending needed to achieve IRENA's 1.5°C scenario, which seeks to limit warming to 1.5°C above pre-industrial levels.
Source: IRENA, 2021.

Economic Drivers of Clean & Renewable Energy

- **Affordable Electricity**: Becoming cheaper than electricity produced by fossil fuels (see following sections)
  - Amazon & Walmart, among others, already announced plans to decarbonize using renewable energy and clean technologies[1]
- **Energy Independence:** 75% global population lives in country that is net importer of fossil fuels. Renewable energy could = energy independence[2]
- **Labor:** Employment in renewables is rapidly growing & should increase as the transition continues, especially following COVID-19 pandemic

Solar Energy as a Decarbonization Tool

- **Clean & Renewable**: power generation produces no direct emissions
  - After 3 years of operation, a solar panel pays off "carbon debt" from manufacturing[3]
- **Scalability:** Solar is one of the easiest renewable sources to scale
  - In many markets solar energy = least expensive electricity, can be quickly integrated, & requires little maintenance

Wind Energy as a Decarbonization Tool

- **Clean & Renewable**: power generation produces no direct emissions
  - After 6 months–1 year of operation, a wind turbine pays off "carbon debt" from manufacturing[3]
- **Efficiency:** More efficient than many other cost competitive options
  - 35-50% efficient, more efficient than most fossil fuel powerplants[4,5]

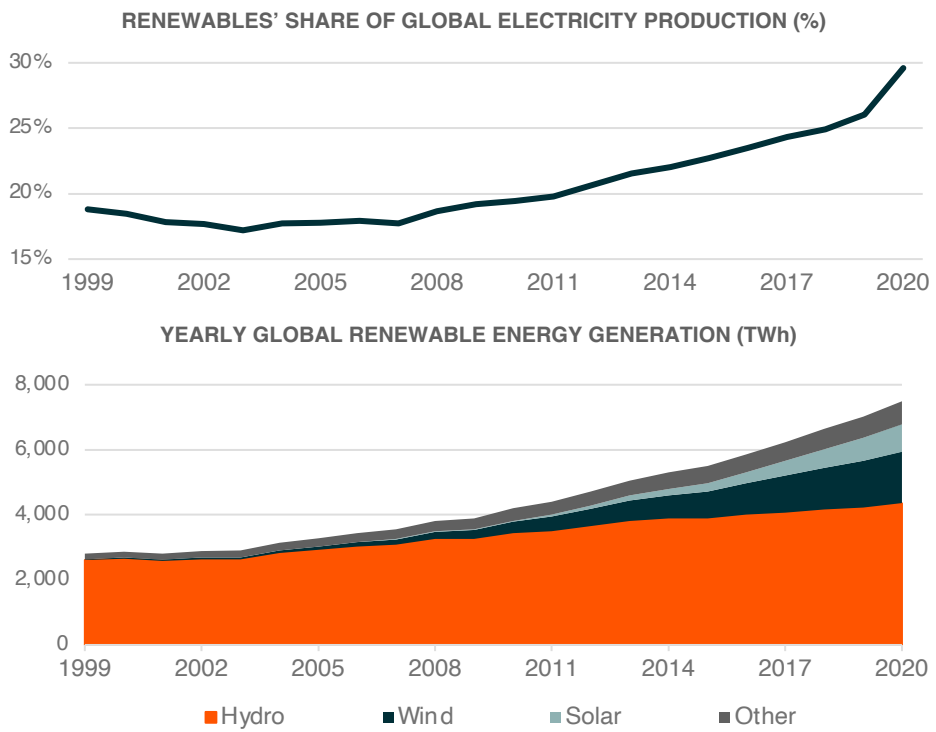
Sources: 1. Bloomberg, "Amazon Tries to Make the Climate Its Prime Directive," Sep 21, 2020.; 2. IRENA, "World Energy Transitions Outlook: 1.5 °C," June 2021.; 3. Saskwind, "Carbon and Energy payback of a wind turbine," Jan. 2016.; 4. IRENA, "Renewable Power Generation Costs in 2020," June 2021.; 5. ECOFYS, "International comparison of fossil power efficiency and CO2 intensity," Sep. 2018.

CleanTech/Renewables: Renewable Energy Sources

Renewable energy is collected from resources that replenish naturally. Renewable energy generation is growing in absolute terms and market share. Renewables produced nearly 30% of global electricity in 2020, up from 19% in 2010.[1]

- **Wind Energy**
  - Onshore wind
  - Offshore wind
- **Solar Energy**
  - Utility scale
  - Residential (grid-tied or off-grid)
- **Hydropower**
  - Dammed or 'run of the river' hydro power
  - Tidal power
- **Geothermal Energy**
  - Dry steam
  - Flash steam

RENEWABLES' SHARE OF ELECTRICITY PRODUCTION CONTINUES TO RISE, DRIVEN BY INCREASED WIND & SOLAR GENERATION



Sources: 1. IEA, "Global Energy Review 2021,"; 2. Our World in Data, "Modern renewable energy generation by source, World," 2021.

Source: 1. IEA, "Global Energy Review 2021," Apr 2021

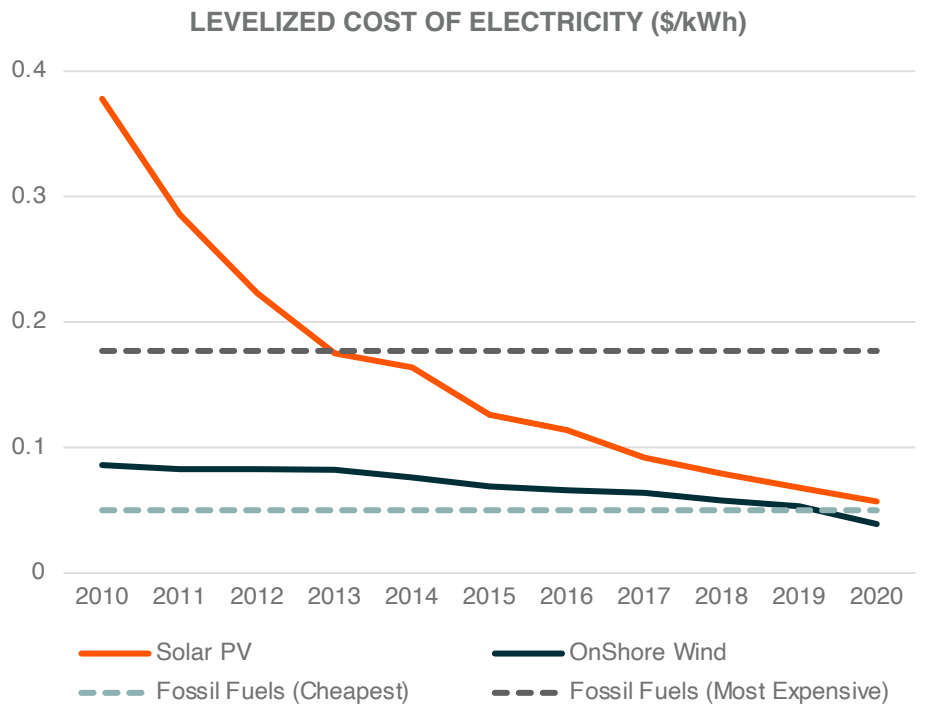
CleanTech/Renewables: Transitioning to Renewable Electricity

Substituting fossil-fuels with clean alternative energy sources could reduce emissions by 52% of what is needed to adequately limit warming.[1]

Transformation in the Power Sector

- **Supportive Policies/ Investment Enable Scale**
  - Investment averaged $600B per year over the past 5 years[2]
- **Decreasing Costs Over the Last Decade**[3]
  - The levelized cost of electricity (LCOE) of solar decreased 80%
  - On/offshore wind LCOE decreased 55%
- **Future Growth**
  - From now to 2050, investments in wind and solar capacity could reach an average $1 trillion per year to effectively scale renewable electricity.[4]

RENEWABLE ELECTRICITY COSTS ARE BECOMING COMPETITIVE WITH THE CHEAPEST FOSSIL FUELS



Source: Global X ETFs, IRENA, June 2021.

Sources: 1. IRENA, "Global Renewables Outlook: Energy Transformation 2050," April 2020.; 2. Energy Transitions Commission, "Making Mission Possible: Delivering a Net-Zero Economy," Sep 2020.; 3. Energy Transitions Commission, "Making Mission Possible: Delivering a Net-Zero Economy," Sep 2020.; 4. Ibid.

CleanTech/Renewables: Transformation Beyond the Power Sector

Improvements in pricing dynamics have driven adoption of solar and wind over the last decade. Further innovation in efficiency and manufacturing processes could drive costs down further.

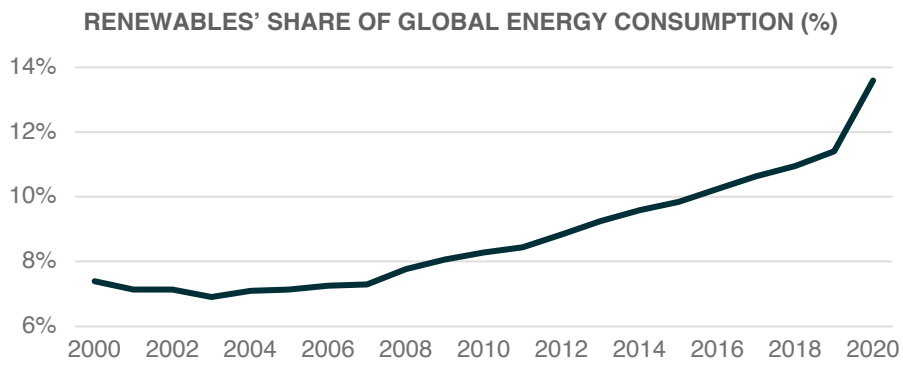
Expanding Renewables' Energy Share

- **Modernized Power Systems:** Accommodating variable renewable energy (VRE)
- **Electrification:** Direct vs. indirect
- **Energy Efficiency:** Electric energy > combustion energy

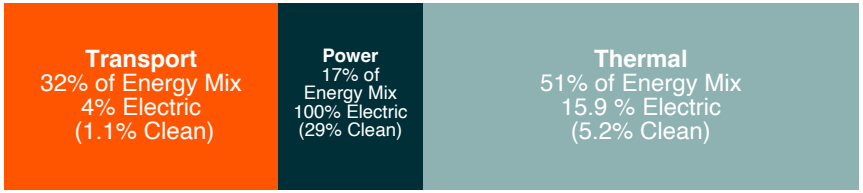
Electrification & Energy Efficiency Explained

- **Transportation:** Continued adoption of EVs and build out of charging infrastructure bodes well for electrification of transportation sector
- **Buildings:** Electric heat pump adoption must increase 10x between now and 2050 for adequate decarbonization. Energy efficiency benefits should help drive this adoption[2]
- **Building Infrastructure:** Electric heat pumps are 300% efficient vs. gas boilers which are 90% efficient[3]
- **Electric Transportation Infrastructure:** Electric engines are 90% efficient vs. internal combustion engines which are 20-40% efficient[4]

RENEWABLES' SHARE OF GLOBAL ENERGY MIX LAGS POWER SECTOR



SECTOR SHARE OF TOTAL ENERGY USE (%)
ELECTRICITY/CLEAN POWER SHARE OF SECTOR ENERGY USE (%)



Note: Thermal refers to heating/cooling in industry and buildings.
Sources: 1. IEA, "Global Energy Review," April 2021.; 2. Source: REN21, IEA, Global X ETFs, July 2021.

Sources: 1-2. IRENA, "Global Renewables Outlook: Energy Transformation 2050," April 2020.; 3-4. Energy Transitions Commission, "Making Mission Possible: Delivering a Net-Zero Economy," Sept. 2020.

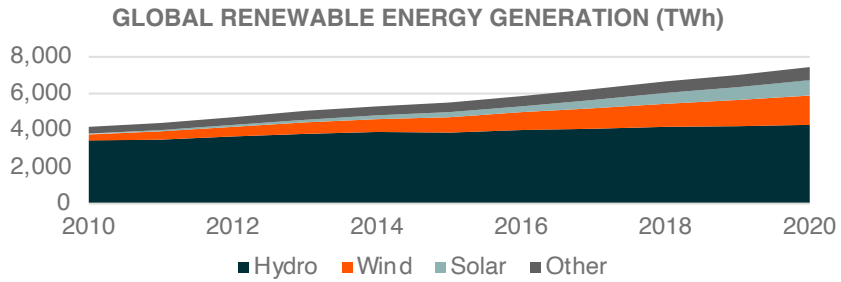
Solar Power: Disrupting the Power Mix with Solar

Currently solar represents about 1.4% of the world's primary energy consumption and 3.3% of electricity production. Such metrics represent both strong historical growth and continued opportunity for future adoption.[1]

Past/Present Growth Drivers (LCOE = Levelized Cost of Electricity)

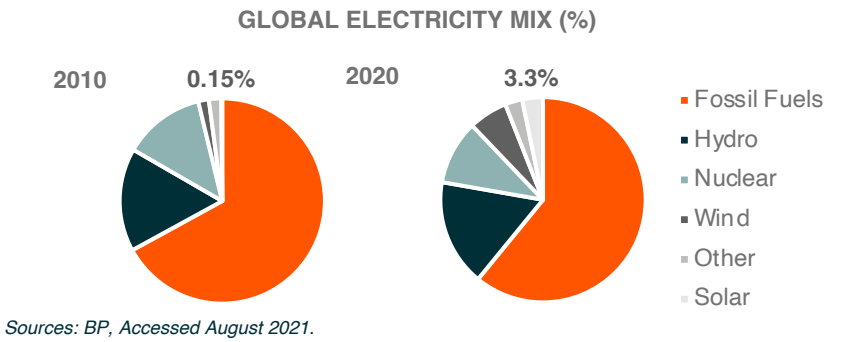
- **Decreasing Costs:** Once niche, solar provides some of world's cheapest power
  - LCOE of utility-scale solar fell 85% between 2010 & 2020[2]
- **Efficiency:** Improvements in efficiency contribute to savings & justify usage
  - Early solar panels 1% efficient, today average is 15–20%[3]
- **Government Support:** Increasingly recognize threat of climate change, providing support/incentives such as subsidies, tax credits & rebates
  - EX: U.S. Solar Investment Tax Credit (ITC) – 26% tax credit for solar systems on residential & commercial properties[4]
- **Independence:** Governments favor energy sources that stimulate domestic economies/don't rely on foreign trade
  - On-grid solar = customers participate in electric utilities
  - Off-grid solar reduces utility dependence
- **Enabling Technologies**
  - Electrification: Only 37% of total final energy consumption comes from electricity. Electrifying remaining 63% would expand solar power's reach[5]
  - Storage: Future deployment of battery/hydrogen storage should accommodate variable renewable energy sources

SOLAR'S SHARE OF GLOBAL RENEWABLE POWER GENERATION REACHED 11.5% IN 2020



Sources: BP, Accessed August 2021.

SOLAR PV'S SHARE OF THE GLOBAL POWER MIX GREW 22x SINCE 2010, REACHING 3.3% BY THE END OF 2020



Sources: BP, Accessed August 2021.

Sources: 1. Our World in Data, "Renewable Energy," Accessed August 2021.; 2. IRENA, "Renewable Power Generation Costs in 2020," June 2021.; 3. Energy Sage, "How solar panel cost and efficiency have changed over time," January 2021.; 4. Department of Energy, "Residential and Commercial ITC Factsheets," February 2021.; 5. REN21, "Renewables 2021: Global Status Report," 2021.

Solar Power: Costs – Current Dynamics & Outlook

Since 1976, solar module costs declined an average of 20.2% for every doubling of capacity.[1] Further capacity expansion could push down future prices in a cycle of adoption and cost improvements.

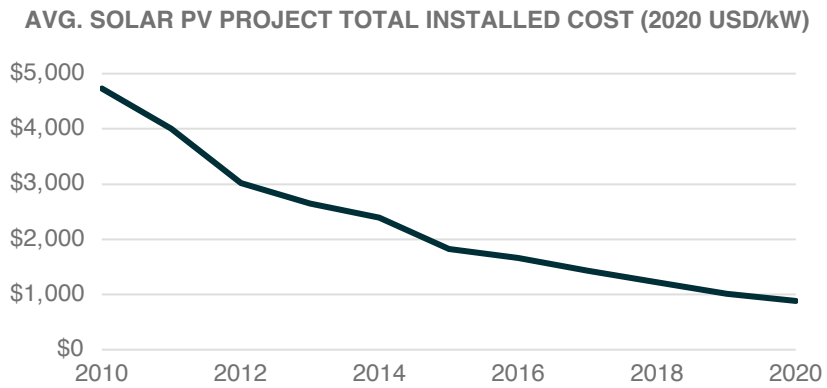
Understanding Solar PV System Costs (2020 avg.)[2]

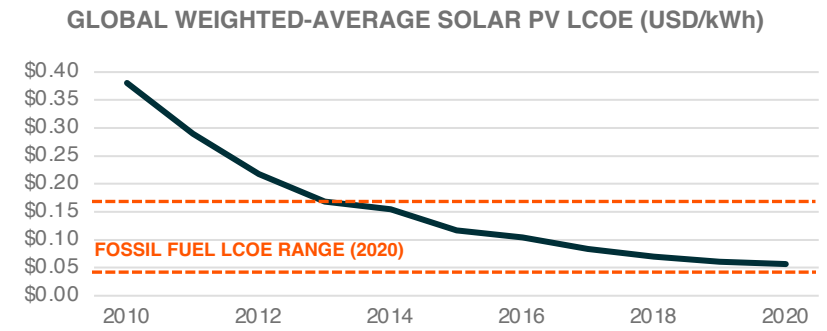
- **Balance of Systems (BoS)** = 65% total installed cost
  - Include all components of a PV other than the panel/module
- **Solar Panel/Module** = 29% total installed cost
  - Applicable Commodities: silicon, gallium, silver, copper
- **Solar Inverter** = 5% total installed costs (often grouped with BoS)
  - Module/inverter cost reductions accounted for 61% of decline in global weighted-average total installed cost 2010–2020

Long-Term Outlook

- **Outlook:** Solar costs projected to decline further 55% from 2019 levels by 2030[3]
- **Efficiency:** More energy per unit of space reduces BoS costs
  - Perovskite layers, negatively charged polysilicon, and bi-facial panels are some technologies that could help boost efficiency[4]
- **Services:** Panel manufacturing costs declined sharper than most other components of the solar value chain
  - Land, construction, engineering, shipping & maintenance costs now account for a high portion of total costs[5]

DECREASING COMPONENT COSTS & EFFICIENCY IMPROVEMENTS ARE DRIVING DOWN OVERALL COSTS





Sources: IRENA, Pvxchange, Global X ETFs, June 2021.

Sources: 1. Our World in Data, "A short history of solar…," December 2021.; 2. IRENA, "Renewable Power Generation Costs in 2020," June 2021.; 3. Energypost.eu, "Analysis shows Wind and Solar costs will continue to fall dramatically throughout the 2020s," November 2020.; 4. Bloomberg, "Solar Is Dirt-Cheap and About to Get Even More Powerful," July 2021.; 5. Ibid.

Solar Power: The Future of Solar

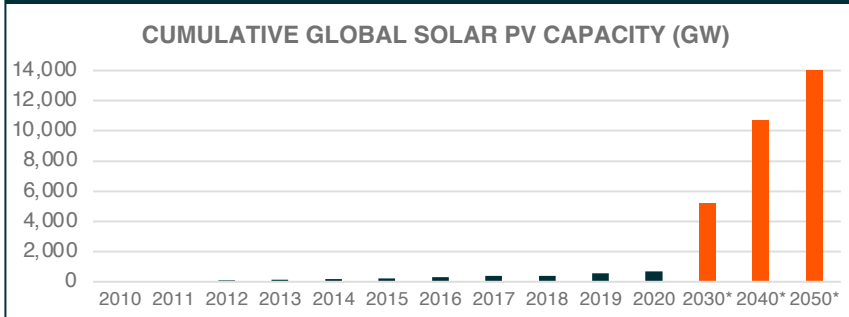
Innovations in solar technology could make the energy source more efficient, cheaper, and increasingly versatile. Such enhancements along with previously mentioned long term drivers could support rapidly increasing capacity.

Innovations

- **Multi-Junction Solar Cells:** Cells made up of multiple semiconducting materials improving efficiency by allowing absorbance of broader range of wavelengths
- **Thin Film Solar Cells:** Semiconducting materials printed on to surface with improved efficiency, flexible installation
- **Solar Windows:** Tinted windows that capture solar energy, with 5B+ m^2 of glass in U.S., could supply 40% of energy demands[1]
- **Solar Paint:** Applied to the surface of buildings or vehicles to capture solar energy
- **Floating Solar Farms:** Installed on bodies of water with 5-15% greater efficiency due to water cooling[2]
- **Next-Gen Materials:** Modules built from new metals such as perovskite could be bigger, cheaper & more efficient than those made from silicon[3]
- **Advanced Operation:** Innovations ranging from robotic cleaning to data-driven failure prevention could cut down on maintenance and operating costs

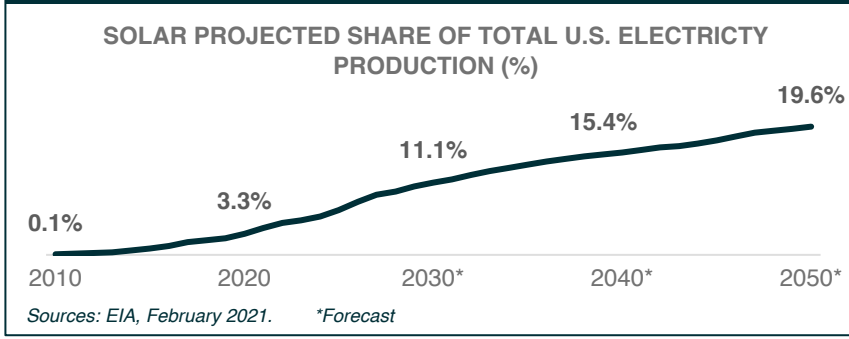
The value of the global solar industry could exceed $800B by 2028, growing at a 14.6% Compound Annual Growth Rate (CAGR) 2021-2028.[4]

INNOVATION & ACOMODATIVE POLICY COULD BOOST SOLAR CAPACITY MORE THAN 7X 2020 LEVELS BY 2030



Sources: IRENA, July 2021. **Forecast*

THE U.S. COULD GENERATE ALMOST 20% OF ITS ELECTRICITY FROM SOLAR BY 2050



Sources: EIA, February 2021. **Forecast*

Sources: 1.Michigan State, "Transparent solar technology…," October 2017.; 2.EESI, "Floating a New Solution for Solar Deployment," March 2021. 3. Okinawa Institute Of Science And Technology, "Game-Changer in Future Solar Technology: New Perovskite Solar Modules With Greater Size, Power and Stability, January 2021. 4. Research Dive, "Solar Energy Market Report," June 2021.

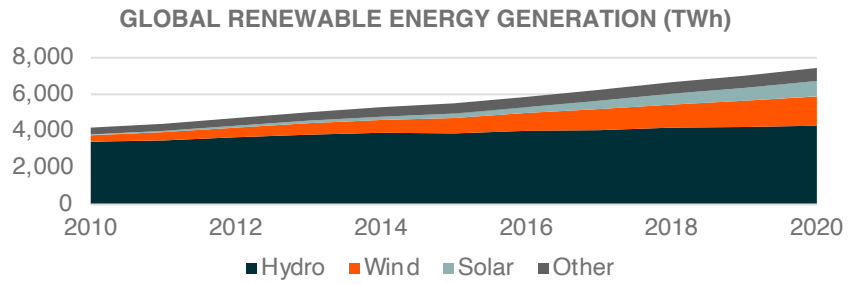
Wind Energy: Disrupting the Power Mix with Wind Power

Currently wind energy represents about 2.6% of the world's primary energy consumption and 6.2% of electricity production.[1] Such metrics represent both strong historical growth and potential opportunity for future adoption.

Past/Present Growth Drivers (LCOE = Levelized Cost of Electricity)

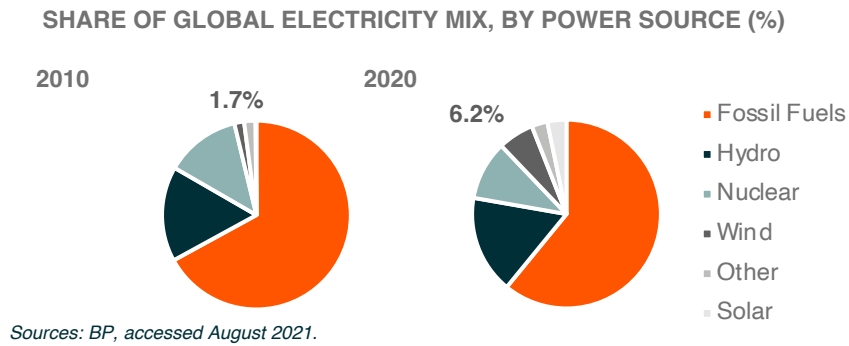
- **Decreasing Costs:** Onshore wind energy provides some of the world's most inexpensive power, offshore is now competitive with fossil fuels
  - Onshore LCOE fell 56% & Offshore LCOE fell 48% 2010–2020[2]
- **Innovation:** Improvements in efficiency/output reduce costs & justify usage
  - Capacity Factor (2010-2020): onshore +56%, offshore +48%[3]
  - Sustained Output (2010-2020): onshore +60%, offshore +143%[4]
- **Government Support:** Policy-makers increasingly recognize the threat of climate change, providing support/incentives like subsidies, tax credits, & rebates
  - EX: U.S. Production Tax Credit (PTC) – $18/mWh tax credit for electricity generated from eligible renewable sources[5]
  - Upcoming projects: Dogger Bank (U.K.), Empire Wind (U.S.)
- **Enabling Technologies**
  - Electrification: Only 37% of total final energy consumption comes from electricity. Electrifying remaining 63% would expand wind power's reach
  - Storage: Future deployment of battery/hydrogen storage should accommodate uneven output of variable renewable energy sources

WIND ENERGY'S SHARE OF GLOBAL RENEWABLE ENERGY GENERATION REACHED 21.4% IN 2020, UP FROM 8% IN 2010



Sources: BP, accessed August 2021.

WIND ENERGY'S SHARE OF GLOBAL ELECTRICTY MIXES INCREASED MORE THAN 3x SINCE 2010



Sources: BP, accessed August 2021.

Sources: 1. Our World in Data, "Renewable Energy," Accessed August 2021.; 2. IRENA, "Renewable Power Generation Costs in 2020," June 2021.; 3. Energy Sage, "How solar panel cost and efficiency have changed over time," January 2021.; 4. Department of Energy, "Residential and Commercial ITC Factsheets," February 2021.; 5. REN21, "Renewables 2021: Global Status Report," 2021.

Wind Energy: Costs – Current Dynamics & Outlook

Total installed costs for onshore & offshore wind decreased 17% and 9% respectively since 2010 for each doubling of capacity.[1] Further capacity expansion could help push down future prices in a cycle of adoption and cost improvements.

Understanding Onshore Wind Costs (2020 avg.)[2]

- **Turbine =** 64–84% of total installed cost
  - Prices of U.S. turbines are down 57% since 2008 due to manufacturing & design improvements
- **Other Costs:** Installation, grid connection & development

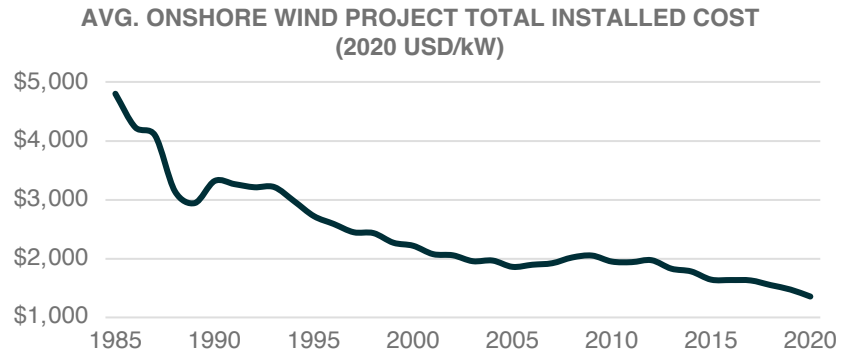
Understanding Offshore Wind Costs (2020 avg.) [3]

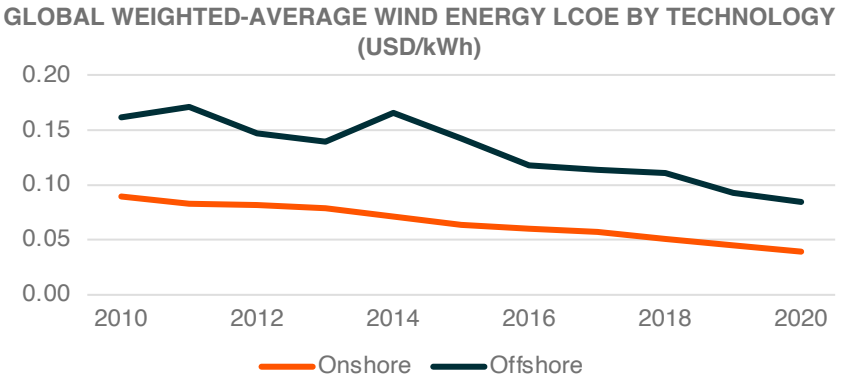
- **Turbine =** 33–44% of total installed cost
- **Installation Costs =** 57–67% of total installed cost
  - Electrical interconnection & foundation building are largest components
- **Operation & Maintenance =** 16–25% of LCOE
  - Improvements in knowledge and specialized technology for marine environments drives down costs

Long-Term Outlook

- **Onshore:** LCOE could decline 45% from 2019 levels by 2030[4]
- **Offshore:** LCOE could decline 50% from 2019 levels by 2030[5]
- **Capacity Factor:** Could reach around 60% for both onshore & offshore by 2050[6]

DECREASING COMPONENT COSTS & EFFICIENCY IMPROVEMENTS ARE DRIVING DOWN WIND ENERGY COSTS





Sources: IRENA, June 2021.

Sources: 1–5.IRENA, "Renewable Power Generation Costs in 2020," June 2021.; 6. IRENA, "Future of Wind," October 2019.

Wind Energy: The Future of Wind Energy

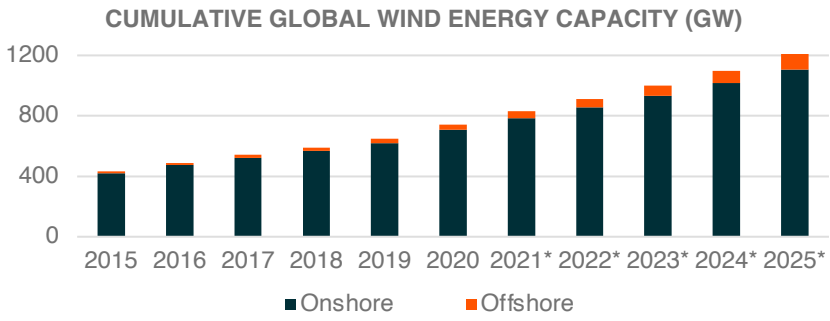
Innovations in wind technology could make the energy source more efficient, resilient and versatile as well as easier to install. Such enhancements along with previously mentioned long term drivers could support rapidly increasing capacity.

Innovations in Wind Energy

- **Advanced Materials:** Use of carbon fiber makes turbines stronger, slenderer, and up to 25% lighter[1]
- **Larger Blades:** 206m diameter rotors can increase capacity factor by 10%, enabling low wind speed function[2]
- **Flexible Blades:** Allowing blades to bend increases blade endurance, helps overcome turbine delivery issues
- **Lightweight Generators:** Lighter weight generators impact tower construction and can reduce overall costs
- **Repair Robots:** Autonomous repair and inspection of turbines can improve operational logistics
- **Tower Engineering:** Hybrid steel/concrete towers with lattice base structure and tubular top
- **Next-gen Offshore:** Floating turbines & airborne/kite wind energy can capture powerful winds in even deeper waters

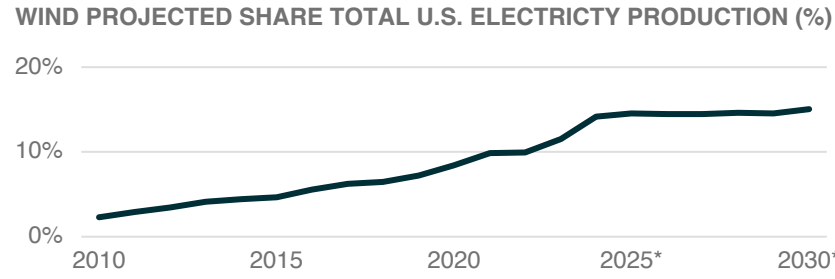
The value of the global wind industry could exceed $180B by 2027, growing at a 4.6% Compound Annual Growth Rate (CAGR) from 2021-2027.[3]

INNOVATION & ACOMODATIVE POLICY COULD INCREASE WIND ENERGY CAPACITY 39% FROM 2020 LEVELS BY 2025



Sources: GWEC, March 2021. **Forecast*

THE U.S. COULD GENERATE 15% OF ITS ELECTRICITY FROM WIND BY 2030



Sources: EIA, February 2021. **Forecast*

Sources: 1. U.S. Department of Energy, "Optimized Carbon Fiber Composites in Wind Turbine Blade Design," December 2019.; 2. U.S. Department of Energy, "Flexing the Limits of Land-Based Wind Turbine Rotor Growth," January 2021.; 3. Global Market Insights, "Wind Energy Market," April 2021.

Hydrogen: Storing Clean Power

The lack of adequate energy storage threatens the flexibility of electrical grids worldwide and stalls the adoption of renewables. Electrolysis can provide indirect electricity in hydrogen, which can hold energy for extended periods of time.

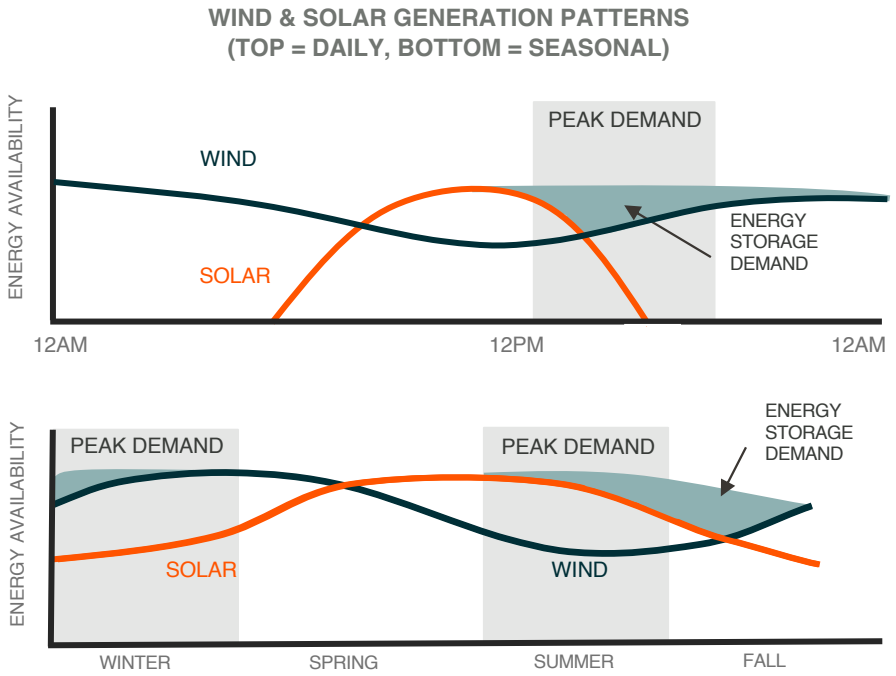
Variable Renewable Energy

- **Storage Needs**: In most markets renewable energy production does not align with peak electricity demand[1]
- **Limited Reach:** Achieving 80% clean power entails U.S. storage increasing 5x by 2050[2]

Hydrogen as a Solution

- **Storage Potential:** Electrolysis powered by excess renewable power will yield hydrogen preserving energy for later use with limited degradation
- **Indirect Electrification:** Using electricity as an input to industrial processes rather than the immediate replacement of fossil fuels
- **Limitations:** Current electrolysis is costly and inefficient while the infrastructure to incorporate hydrogen into needs building[3]

LONG-TERM ENERGY STORAGE CAN ENABLE VARIABLE RENEWABLE ENERGY INTEGRATION. H_2 COULD MEET THESE NEEDS



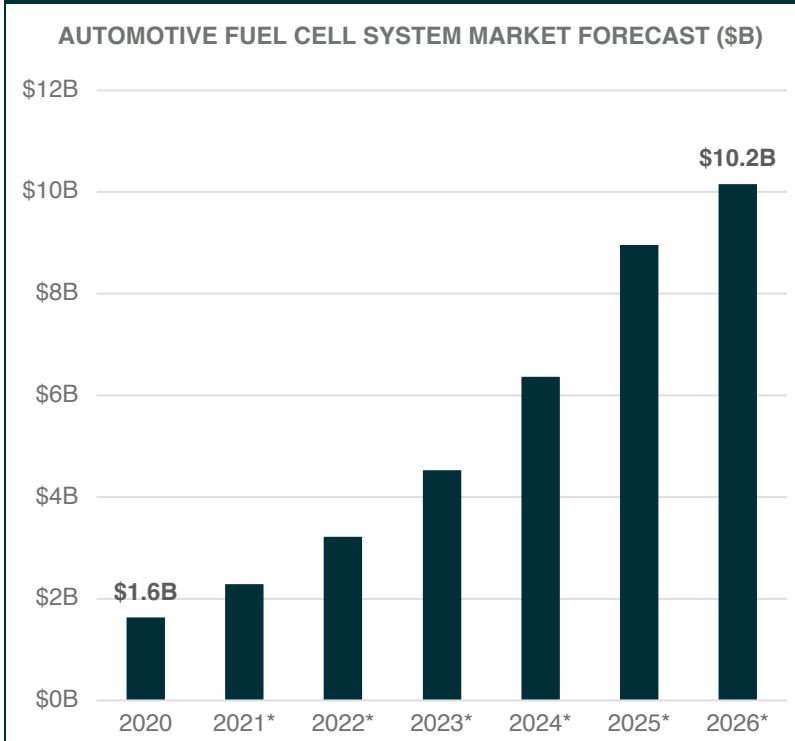
Note: Graphic is illustrative & does not reflect exact or approximate numbers.
Source: Congressional Research Service, Global X ETFs, July 2021.

Sources: 1. Congressional Research Service, "Variable Renewable Energy: An Introduction," June 25, 2019.; 2. NREL, "Declining Renewable Costs Drive Focus on Energy Storage," Jan. 2020.; 3. IRENA, "Green Hydrogen Cost Reduction," 2020.

Hydrogen: As a Fuel Source

Fuel cells harness hydrogen to electrify difficult to decarbonize segments such as transportation and buildings.

THE MARKET FOR AUTOMOTIVE FUEL CELL SYSTEMS COULD GROW RAPIDLY OVER THE NEXT FIVE YEARS



Source: Mordor Intelligence, March 2021 **Forecast*

Transportation Fuel Cells – Fuel Cell Electric Vehicle (FCEV)

- **Impact:** Transportation generates 25% global greenhouse gas emissions[1]
- **Transportation Fuel Cell:** Generates electricity via electrochemical reaction rather than combustion, with only water and heat as biproducts
  - Supported by H_2 tank, batteries, and engines to power FCEVs
- **Drivers:** Long range, light weight, short refill time, consistent performance[2]
- **Alternatives:** Lithium batteries too heavy for commercial trucking, etc.
  - 1% increase in mass of terrestrial vehicle leads to 0.37-0.57% increase in energy use[3]

Fuel Cells in Buildings

- **Impact:** Buildings = 33% global energy demand & 25% emissions[4]
- **Stationary Fuel Cell:** Replaces natural gas as a source of heat & power in buildings / key infrastructure
- **Drivers:** Efficiency, declining cost, space saver, limited alternatives
  - Solar needs 100x land, wind needs 500x more (per megawatt, MW)[5]
- **Outlook:** Heat & power fuel cells could be commercially viable by 2030[6]

Sources: 1. Brookings, "The Challenge Of Decarbonizing Heavy Transport," October 2020.; 2. BMW, "Hydrogen fuel cell cars:…," September 22, 2020.; 3. The Conversation, "Climate explained: why don't we have electric aircraft?," September 2019.; 4. IEA, "Net Zero by 2050 – A Roadmap for the Global Energy Sector," May 2021.; 5. FCHEA, "Stationary Power," Accessed July 2021.; 6. Hydrogen Council, "Path to Hydrogen Competitiveness: A Cost Perspective," Jan 2020.

Hydrogen: As an Input

As an input, clean hydrogen moderates the environmental impact of carbon intensive industrial processes. Plus, hydrogen-blended fuels can reduce the carbon intensity of transportation segments where fuel cells are impractical.

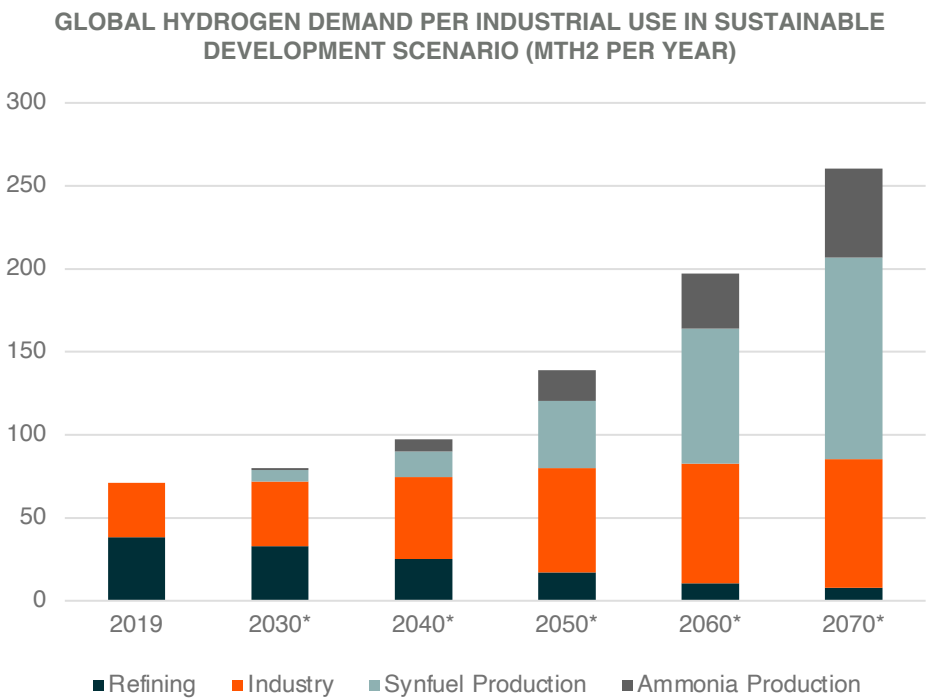
Industrial Input – Indirect Electrification

- **Steel:** Could replace a larger portion of carbon intensive inputs[1]
- **Refineries:** Reduces sulfur content & other impurities in crude oil[2]
- **Chemicals:** Feedstock for several vital industrial chemicals

Hydrogen in Fuel[3]

- **Hydrogen-Rich Fuels:** Blended fuels offer more volumetric energy content than pure H_2 while requiring few changes to preexisting power apparatus
- **Aviation:** Future airplanes likely powered by mixture of biofuels and hydrogen syn fuels to balance emissions, weight, and energy
- **Shipping:** Ammonia may power over half of shipping energy mix in 2050

THE DEMAND FOR HYDROGEN IN ALTERNATIVE FUEL PRODUCTION IS LIKELY TO SURPASS DEMAND FOR HYDROGEN IN REFINING BY 2050



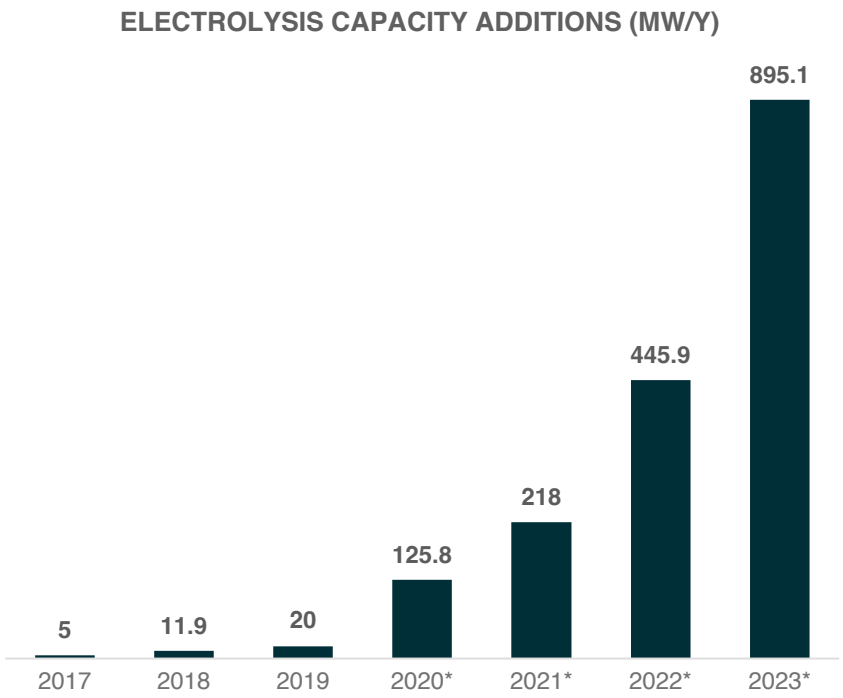
Source: Source: IEA, September 2020 *Note: MTH_2 refers to megatonne of hydrogen gas *Forecast*

Sources: 1. FCHEA, "Hydrogen as a Clean Alternative in the Iron and Steel Industry," November, 2019.; 2. EIA, "Hydrogen for refineries is increasingly provided by industrial suppliers," January 2016.; 3. Energy Transitions Committee, "Making Mission Possible Delivering a Net-Zero Economy," September 2020.

Hydrogen: Transitioning to Renewable Production

Although industrial process generated 87M tons of hydrogen in 2020, the notion of clean hydrogen remains in its nascent stages.[1] Renewably powered electrolysis is a solution to produce hydrogen with zero emissions.

DECREASING ELECTROLYZER COSTS ARE DRIVING PLANS TO ADD SIGNIFIGANT CAPACITY IN THE COMING YEARS



*Note: Data was published by IEA in June of 2020: MW/y = megawatts per year; *Planned Capacity*
Source: IEA June 2020, Hydrogen, IEA, Paris.

Unsustainable Hydrogen Production

- **Market Share:** 95% of hydrogen derived from natural gas via carbon intensive steam methane reforming / gasification[2]
- **Cost Components:**
  - Renewable Energy: roughly 27% of electrolyzer system costs[3]
  - Electrolysis: inefficiency and stack components contribute to total cost

Hydrogen Endgame Relies on Clean Tech Advances

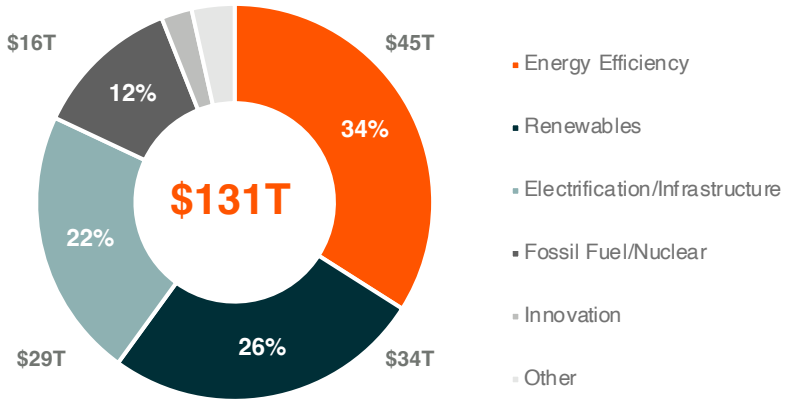
- **Status:** Pricing dynamics are improving as electrolysis & renewables scale
  - In 2010 green hydrogen production was more than 2.6x more expensive than today and could reach cost parity with unsustainable hydrogen in 7 – 13 years[4, 5]
- **Renewables:** Accessible supply needed to generate clean hydrogen
- **Electrolysis Targets**: Electrolyzers must scale & improve to optimize inputs
  - Minimum 65GW capacity needed for green hydrogen to breakeven with grey hydrogen – 200 MW in 2020[6]

Sources: 1. Recharge News, "A net-zero world 'would require 306 million tonnes of green hydrogen…," May 2021.; 2. IRENA, "Green Hydrogen A Guide To Policy Making," 2020.; 3. IRENA, "Green Hydrogen Cost Reduction," 2020.; 4. IRENA, "Green Hydrogen Policy," Nov. 2020.; 5. Hydrogen Council, "Hydrogen Insights: A perspective on hydrogen…," Feb 2021.; 6. Ibid.

CleanTech/Renewables: Building Green Capacity

CLIMATE CHANGE MITIGATION EFFORTS REQUIRE SIGNIFICANT INVESTMENT IN CLEANTECH & RENEWABLE ENERGY CAPACITY

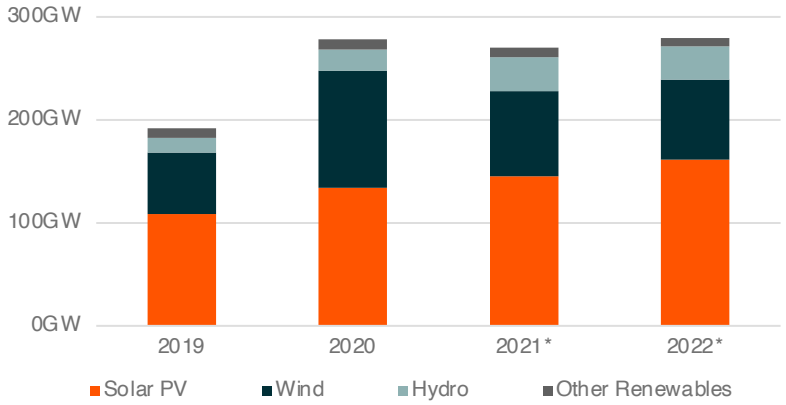
CUMULATIVE INVESTMENT NEEDED BETWEEN 2021 & 2050 ($T)



Note: Investments needed to limit temperature increases to 1.5°C above preindustrial levels
Source: IRENA, "World Energy Transitions Outlook," June 2021.

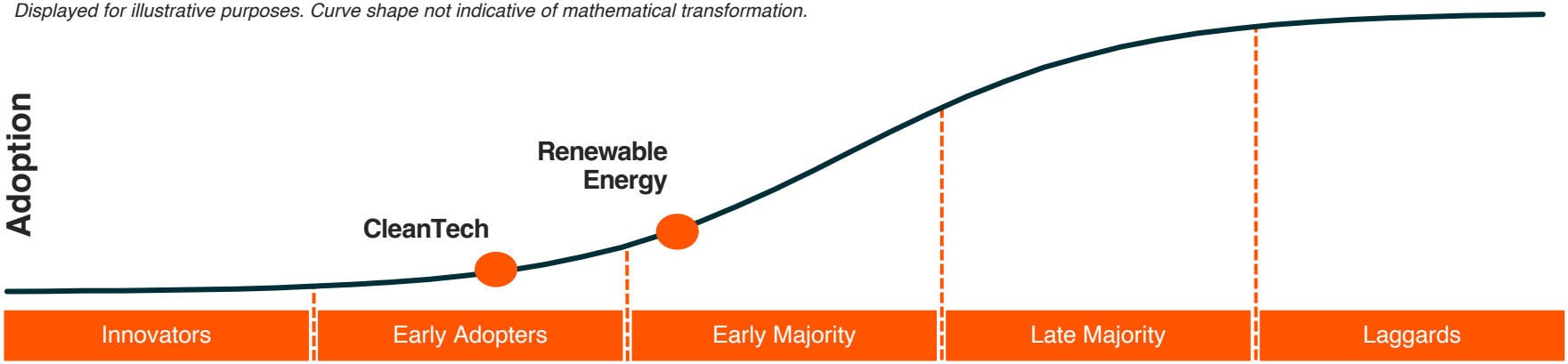
RENEWABLES COULD ACCOUNT FOR 90% OF TOTAL GLOBAL POWER CAPACITY INCREASES IN BOTH 2021 AND 2022

PROJECTED GLOBAL NET RENEWABLE CAPACITY ADDITIONS BY TECHNOLOGY (GW)



Source: IEA, May 2021.

Displayed for illustrative purposes. Curve shape not indicative of mathematical transformation.



GLOBAL X
by Mirae Asset

Thank you.

GLOBAL X
by Mirae Asset

Appendix

Global X Thematic Growth ETF Suite in UCITS

Global X has 16 ETFs designed to target companies that may benefit from disruptive structural changes in technology and innovation and people and demographics[1]

Disruptive Technology

- Video Games & Esports UCITS ETF (HERU)
- Cloud Computing UCITS ETF (CLO)
- Robotics & Artificial Intelligence UCITS ETF (BOTZ)
- Cybersecurity UCITS ETF (BUG)
- Autonomous & Electric Vehicles UCITS ETF (DRVE)
- FinTech UCITS ETF (FINX)
- Internet of Things UCITS ETF (SNSR)
- Lithium & Battery Tech UCITS ETF (LITU)
- Data Center REITs & Digital Infrastructure UCITS ETF (VPN)

People & Demographics

- Telemedicine & Digital Health UCITS ETF (EDOC)
- Genomics & Biotechnology UCITS ETF (GNOM)
- E-commerce UCITS ETF (EBIZ)

Physical Environment

- U.S. Infrastructure Development UCITS ETF (PAVE)
- CleanTech UCITS ETF (CTEK)
- Renewable Energy Producers UCITS ETF (RNRG)
- Clean Water UCITS ETF (AQWA)
- Wind Energy UCITS ETF (WNDY)
- Hydrogen UCITS ETF (HYGN)
- AgTech & Food Innovation UCITS ETF (KROP)
- Solar UCITS ETF (RAYS)

[1]As of 21/03/2022

Defining & Categorising Themes: Global X's Classification System

Category	Mega-Theme	Theme	Sub-Theme
Disruptive Technology	Big Data	Machine/Deep Learning	
		Cybersecurity	
		Quantum Computing	
		Cloud/Edge Computing	Remote Work, MarTech
	Mobility	Autonomous Vehicles	
		Electric Vehicles	Lithium/Batteries
	Digital Experiences	AR/VR	
		Video Games	E-sports
		Social Media	
		Streaming	
	FinTech	Mobile Payments	
		Peer-to-Peer Lending	
		Crowdfunding	
		Blockchain	
	Connectivity	Digital Infrastructure	
		5G/Next Gen Networking	
		Emerging Markets Internet	
		Internet of Things	Smart Devices, Smart Cities, IIoT
		Space/Satellite Communications	
	Robotics	AI/Automation	
		3D Printing	
		Drones	
People & Demographics	New Consumer	Millennials & Gen Z	
		Emerging Market Consumers	
		Urbanisation	
		E-commerce	
		Education	
		Sharing/Gig Economy	
		Safety and Security	
		Cannabis	
		Sports Betting	
		Professional Sports	
	Health	Healthcare Innovation	Telemedicine & Digital Health, Genomics, Immunotherapy, Public Health
		Aging Population	Senior Care, Senior Economy
		Health & Wellness	Obesity, Organics
		Emerging Markets Healthcare	
		Alternative Medicine	
Physical Environment	Climate Change	CleanTech	
		Clean & Renewable Energy	Solar, Wind, Hydrogen
		Resource Scarcity	Water, Waste/Recycling, Rare Earths, Sustainable Food
	Infrastructure Development		
	Disruptive Materials		

Minerva: Company Profile

Company Overview

Minerva is an independent provider of global research and proxy voting solutions.

Minerva works closely with institutional investors to support and enable their own unique vision of responsible investment through the provision of high-quality data and stewardship support services.

Minerva understands that in order to make sustainable stewardship into a concrete reality, institutional investors need high quality, actionable data and informed insights. The company, therefore, blends a deep knowledge of its clients' investing context alongside advanced skills and capabilities in the field of data science and knowledge management.

Minerva offers a suite of sustainability support services covering the following competencies and deliverables:

- Expert ESG data collection and analysis
- Vote agency administration services
- Post-event vote results, monitoring and reporting
- Sustainable stewardship and engagement services
- Governance, renumeration and sustainability analysis
- Comprehensive knowledge of global market voting procedures
- SDG and ESG framework alignment

Minerva ESG Nexus

Minerva ESG Nexus is a **modern, ESG** research and analysis framework which moves beyond traditional negative screening to combine a comprehensive range of regulation and investor-led ESG monitoring practices.

Based on the three pillars of 'products', 'conduct' and 'governance', the Minerva ESG Nexus framework offers a comprehensive, data-driven approach to embed the **UN Global Compact, UN Sustainable Development Goals** and **TCFD** recommendations into a range of investment activities.

Minerva Nexus allows investors to explicitly screen portfolios and companies based on clearly defined products and ESG criteria. Furthermore, investors can identify top performing or laggard companies on key topics such as executive remuneration, governance and/or sustainability, based on Minerva's tried and trusted objective rating system. As a basis for engagement and voting, indicators can be embedded in custom voting policies.

Rather than imposing a one-size-fits-all approach, Minerva Nexus allows users to explore a full range of topics and develop their own approach, confident that the data is objective and rigorous.

Minerva Nexus is, however, not merely an AI web-scraping technology solution. Expert analysis using trusted primary resources is central to the offering.

Minerva: ESG Screening

As part of the index methodology for the Solactive Clean Water index Minerva carries out two separate screens below:

Controversial Products:

A controversial products screen reviews companies on their involvement in controversial products. Each type of controversial product has different thresholds to identify involvement, which if reached, may warrant an exclusion.

Controversial products are those which pose a material risk due to a large portion of investors perceiving them as offensive, embarrassing, harmful, socially unacceptable, or ethically objectionable.

The following areas can be included in a controversial products ESG screen:

- **Weapons**
  - Controversial Weapons: Depleted Uranium, Nuclear Weapons, Cluster Munitions, Anti-Personal Mines, White phosphorus weapons and Military & tailor-made products for weapons.
  - Small Arms: Civilian firearms.
- **Energy**
  - Fossil Fuels: Coal, Conventional and Unconventional Oil & Gas
- **Controversial Activities**
  - Palm Oil
  - Prisons
  - Adult Entertainment
- **Public Health Concerns**
  - Recreational Cannabis
  - Tobacco
  - Alcohol
  - Gambling

United Nations Global Compact:

This screen includes reviewing company adherence to the UN Global Compact Principles (UNGC).

The UNGC pillars are underpinned by Ten Principles which promote the integration of sustainable business practices and transparency.

8,000 companies and 4,000 non-business participants have become signatories to UN Global Compact.

Companies are screened under the following four pillars of the UNGC (including company supply chains):

- Human Rights
- Labour Rights
- Environmental Damage
- Anti-Corruption

Minerva: United Nations Global Compact

Minerva references the United Nations Global Compact (UNGC) Principles and the Organization for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises to assess the behaviour of companies.

In addition to looking at formal breach notifications, Minerva undertakes a comprehensive, expert research process using a range of primary and secondary sources including online media, NGO data, corporate disclosures and official government sources. Sources are screened weekly and detailed audit trails are kept over time.

There are four pillars that are reviewed as part of the UNGC screen: 1) Human Rights, 2) Environmental Damage, 3) Labour Rights and 4) Anti-Corruption.

Minerva has developed a Materiality tool which they use to carry out a review of a company including its supply chain. The Materiality tool allows for the categorisation of events and/or companies that may breach the above fundamental responsibilities.

The tool assesses potential UNGC breaches across two dimensions: Severity (Severe, High, Moderate, Minor) and Frequency.

Based on the determined severity and frequency of the breach, the company is given a score as shown in the Table below:

Severity Level		Definition	Score
	Severe	Indicates an action by a company that results in a severe impact on society and/or the environment. Events assigned to this category represent the most controversial corporate behaviour.	20
	High	Indicates an action by a company that results in a large impact on society and/or the environment	10
	Moderate	Indicates an action by a company that results in a moderate impact on society and/or the environment.	4
	Minor	Indicates an action by a company that results in low impact on society and/or the environment	2
	None	There is no evidence that a company is involved in any controversy.	0

Minerva: United Nations Global Compact

Minerva evaluates whether a company has taken the appropriate steps to remediate the identified issue going forward. To this end, the frequency of the alleged offence is objectively assessed in order to adjust the final severity level score which can be seen by the Severity-Frequency Matrix.

The decision for exclusion is based on relevance, frequency, the scope of the harm, the severity, the risk of recurrence and the irreversibility of the adverse impact caused by the company and by using Minerva's predefined materiality framework to ensure consistency in the evaluation process.

Exclusion is applied where companies clearly fail to demonstrate change or improvements that can mitigate and/or prevent any adverse impact. If an excluded company demonstrates positive change that reduces the risk of recurrence, the company may be re-included, and an Observation score is applied accordingly.

Frequency
How many time the issue has occurred?

Severity Level
How severe the issue is?

	x1	x2	x3	x4	x5+
Severe 20	Severe 20	Severe 40	Severe 60	Severe 80	Severe 100+
High 10	High 10	Severe 20	Severe 30	Severe 40	Severe 50+
Moderate 4	Moderate 4	Moderate 8	High 12	High 16	Severe 20+
Minor 2	Minor 2	Moderate 4	Moderate 6	Moderate 8	High 10+
None 0	None 0	None 0	None 0	None 0	None 0

Exclusions: any Company that receive a severity score of 20 (Severe) will be excluded from the Index. A severity level score of 'Severe' indicates an action completed by a company that has had a severe impact on society and/or the environment.

How supply chains are assessed:

- If there is violation is in the supply chain of a company, there would be a 'High' Severity score of 10 applied. If a company has more than one incidence of a 'High' severity case, Minerva will increase their Severity Score to 'Severe' (as seen above). This then moves the company from an 'Observation' to an 'Exclusion'.
- The multiplicative scoring system applies to multiple violations within the same UNGC pillar, i.e., two labour rights violations or two human rights violations. Please see the criteria below regarding the violation of UNGC principles in the supply chain:

Human rights:	Companies with confirmed violations in their supply chain.
Environmental Damage:	Companies with impactful environmental damage in their supply chain.
Labour Rights:	Companies with confirmed cases of labour rights violations in the supply chain.
Anti-corruption:	Companies associated with another company confirmed of bribery or corruption.

Disclosures

The Global X Thematic Classification System is based on the expertise, views, and opinions of the Global X Thematic Classification Committee and are subject to change. Global X defines thematic investing as the process of identifying powerful disruptive macro-level trends and the underlying investments that stand to benefit from the materialisation of those trends. By nature, thematic investing is a long term, growth-oriented strategy, that is typically unconstrained geographically or by traditional sector/industry classifications, has low correlation to other growth strategies, and invests in relatable concepts.

The process of identifying themes consists of three inexorable principles:

1) There must be high conviction that the theme will materialise and have a meaningful impact on segments of the economy or markets. Often this is due to observable structural changes in technology, demographics, consumer behavior, or the physical environment, but can also be influenced by other factors.

2) A theme must be investable, meaning there are publicly traded companies that provide exposure to the concept. Ideally, the group of companies is broad, have high liquidity, and attribute a substantial portion of their business operations (revenues, assets, research & development) to the theme.

3) A theme must be expected to express itself over a medium to long-term time horizon, generally considered to be five years or longer. A longer-term time horizon makes market timing less of a factor in the success of identifying a theme.

Notably, and taking into consideration the principles above, Global X's thematic investing does not consist of ESG, values-based, or policy-driven strategies, unless they otherwise represent a disruptive structural trend (e.g. climate change). Further, funds that adhere to traditional sector or industry classifications, or that are used primarily to gain exposure to cyclical trends (e.g. currencies, valuations, inflation) are not considered thematic. Finally, alternative asset classes, such as listed infrastructure, MLPs, and ubiquitous commodities are not considered thematic. We recognise that these exclusions may differ from other third-party definitions of thematic investing, but it is consistent with, and core to, Global X's thematic classification system and process.

Based on the definition and principles of thematic investing above, Global X has established a thematic classification system that seeks to identify powerful themes and organise them by common traits and drivers. The system consists of four layers of classifications: 1) Categories; 2) Mega-Themes; 3) Themes; and 4) Sub-Themes, with each layer becoming sequentially narrower in its focus.

'Categories' is the broadest layer and represents three fundamental drivers of disruption: exponential advancements in technology (Disruptive Technology), changing consumer habits and demographics (People & Demographics), and the evolving physical landscape (Physical Environment). One layer down are 'Mega-Themes,' which serve as a foundation to multiple transformative forces that are causing substantial changes in a common area. Conceptually, Mega-Themes are a collection of more narrowly targeted Themes. For example, Big Data is a Mega-Theme that consists of Machine/Deep Learning, Cybersecurity, Quantum Computing, and Cloud/Edge Computing. Further down, we identify 'Themes' as the specific areas of transformational disruption that are driving technology forward, changing consumer demands, or impacting the environment. 'Sub-Themes' are more niche areas, such as specific applications of themes or upstream forces that are driving themes forward.

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