Explore Thematic ESG: Clean Energy

The Invesco White Paper Series
Q3 2022

Invesco ETF Product Strategy & Research

Thematic & Specialty Group

Rene Reyna, CFP®
Head of Thematic & Specialty Product Strategy, ETF & Indexed Strategies

Joe O'Malley
Thematic & Specialty Strategist, ETF & Indexed Strategies

Brandon Knott
Thematic & Specialty Strategist, ETF & Indexed Strategies

Brett Boor, CFA
Senior Analyst, Thematic & Speciality Strategies, ETF & Indexed Strategies

David Davenport, CFA
Analyst, Thematic & Speciality Strategies, ETF & Indexed Strategies

Starting in the early 2000's, renewable energy investing began to capture investor interest. The development of renewable energy represented not just an important solution for climate change but has also proven to be a story that is fundamentally about technology. Now, as the world economy prepares for a true transition to decarbonization, interest in renewable energy has re-emerged as an important topic for investors. In this piece, we examine the history of the renewable energy sector, discuss how technology and policy have transformed the space, and explore alternatives for investing in the industry.

A Long History & A Lost Decade

Despite a 20th century that was dominated by fossil fuels, renewable energy has long captivated the scientific world. As early as the 1800s, scientists like Edmond Becquerel noted that direct exposure to sunlight could produce electricity through some metals - what we now call the 'photovoltaic effect'.[1] In 1954, Bell Labs produced the first solar panel made of silicon.[2] In 1973, the University of Delaware developed Solar One, the first house to use solar panels for energy.[3]

Still, in spite of these technological discoveries, it wasn't until the early 2000s that the technology and its viability were thought about seriously. One clear driver of this change at the time was the rapidly rising price of oil. At the time, the US was still reliant on oil imports, and many years of increases led to oil prices peaking at $140/barrel in June of 2008.[4] Another fear at the time was peak oil, the estimate that the world would use all oil reserves within one hundred or so years. Ultimately, the shale revolution and large reserves of US oil drastically changed this outlook. While the renewable energy industry is no longer reliant on oil prices, these concerns were dominant at the time.

Despite these early drivers, the investing trends of the early 2000s were well ahead of the economics of renewable energy. Many technologies were still in early phases of development and firms were not yet well positioned for success. Below shows the index level of the WilderHill Clean Energy Index (ECO) since inception. The Global Financial Crisis in 2008 set off large losses for the clean energy industry. While the years after showed some recoveries, it also displayed many fits and starts for the industry.

In the case of solar, for example, global investments grew from $66 million in 2000 to $136.6 billion by the end of 2011.[5] This reflects significant backing from governments around the globe, including the US and China. However, this led to deep overcapacity compared to the technology and demand at the time and ended in a wave of bankruptcies in 2011.[5] Policy also continued to be uncertain throughout the period, and a continued reliance on oil as an indicator for how the technology would succeed economically led to heightened volatility.

Exhibit 1: Price History of the WilderHill Clean Energy Index

Source: Bloomberg L.P. as of August 31, 2022. Data from August 16, 2004 through August 31, 2022.

Transformational Change – Competing at Scale

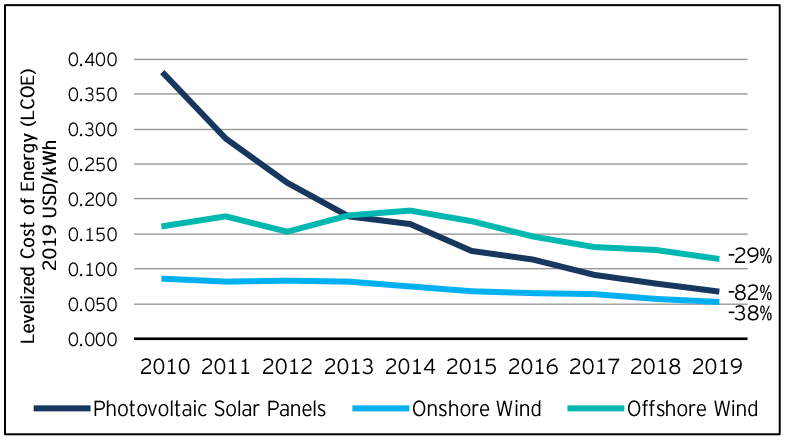
While the trends outlined above led to a difficult period for renewable energy investors, the key technologies within the industry continued to develop at a rapid pace. As with many technologies, climbing the development curve can be difficult and cost intensive, but eventually, know-how is established, scale is reached, and costs fall.

Similar to Moore's law of computing, the solar industry has seemed to follow "Swanson's Law" (coined by Richard Swanson, founder of SunPower) that for every doubling of solar capacity, solar panels decrease 25% in price.[6] To this end, solar panel production capacity increased by 11 times since 2009, rising from 11,000 megawatts to 178,000 megawatts in 2020.[7] Polysilicon, a key component of solar cells, has also developed rapidly as China entered the market, rapidly increasing capacity and competition in what had previously been a concentrated market.[8] All of these improvements led to an 82% decrease in solar panel cost from 2010 to 2019 (see Exhibit 2 below). These changes have allowed renewables to compete more effectively with fossil fuels, even as the price of oil has fallen dramatically, those prices are no longer the primary driver of the industry.

Beyond Cost – Efficiency Gains

Technological improvements are also not just limited to cost. Efficiency has also climbed rapidly, improving overall costs for renewable energy adopters. In the case of solar, US scientists achieved 44.5% efficiency in 2017 in a solar prototype, almost triple that of early solar panels, which began at 14% efficiency in the 1960s. [6]

Exhibit 2 – Declining Costs of Renewable Energy Over Time



Source: IRENA June 2020

Batteries – Becoming a 24-Hour Solution

While much of the buzz around technological progress has been focused on the earliest technologies of solar and wind energy, a wide breadth of technologies have progressed concurrently, which continue to help pave the wave for renewables adoption. One of the best examples of this are the changes in the battery industry.

Batteries have seen similar leaps forward in both technology and scale. Battery costs have fallen by 86% since 2010 and are expected to fall by an additional 57% by 2030.[9] On the technology front, battery materials also continue to improve, allowing for greater density and longevity. Leaders like Mitsui and Sumitomo are building pilot manufacturing facilities of solid-state batteries, which could have densities as much as 45% higher than current lithium-ion models.[9]

One persistent driver of these leaps forward is the electric vehicle market. Recently, Hyundai tested compact electric SUVs that reached 1000 kilometers (620 miles) on a single charge, double the current range. This type of capacity is expected to become standard as new models come to market in coming years.[11]

From Batteries to Solar

Traditionally, solar and wind technologies have been naturally limited by the nature of their resources – the shining of the sun and the blowing of the wind. In key solar markets like Australia, grids can see solar penetration reach upwards of 70% during the day, though the overall weight is closer to 30% when including nighttime quiet periods[9]. However, by integrating batteries, solar and wind could become 24-hour energy solutions, which could continue to increase their adoption.

The Hydrogen Economy

Another technology that bears watching is hydrogen. Hydrogen shows strong green potential – its combustion produces water, and it is primarily produced via electrolysis (splitting water molecules with electricity), which can use renewable electricity to produce green hydrogen.

With the push to decarbonize, hydrogen will also likely be a key solution as sectors like shipping, aviation, and heavy industry have needs that batteries aren't well suited for. On passenger trains, for example, Bloomberg has found that for trips over 100km, hydrogen is necessary. Putting this technology to work, Germany launched a long-distance hydrogen train project and other countries like Japan are working on similar projects.[11]

Similar to other renewable technologies, hydrogen saw some false starts in the early 2000s. However, that was also driven by speculation about a dwindling supply of oil. Now, the push is coming from decarbonization and climate change, a threat that is both nearer-term and more severe than peak oil. Perhaps more importantly, hydrogen has also seen dramatic improvements in technology and cost over the past two decades. With better materials and more efficient membranes, hydrogen fuel cells have declined in cost by about 2/3 since 2006 and have seen their durability double.[12]

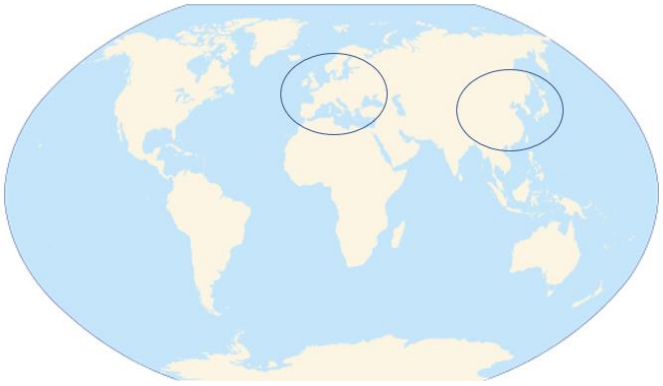
Beyond fuel cells, broader hydrogen costs will also continue to fall. Electrolyzer costs have fallen 50% over the last five years, and countries across the globe are competing to lead in the hydrogen economy. Thirteen countries currently have a national hydrogen strategy with eleven more in development.[13]

Transforming Demand – Policy and the Road to 2050

As discussed above, renewable energy has gone through a technological transformation over the past two decades that has changed the landscape considerably. However, trends developing on the demand side are equally important to consider. As the world attempts to meet the challenge of climate change, countries are embarking on ambitious investment plans to decarbonize their economies. Over the past couple of years, in an attempt to meet their goals under the Paris Climate Accord, more countries have set carbon neutral commitments. We've now seen commitments from the European Union, Japan, China, South Korea, etc. This amounts to 91% of global gross domestic product (GDP)* with a commitment by either 2050 or 2060 (in the case of China).[14]

The United States also looks set to contend for climate leadership under the Biden administration. The Biden climate plan has set a similar target for carbon neutrality by 2050. They have also committed to investing $400 billion in renewable energy to decarbonize the power sector by 2035. Following the recent passage of the Inflation Reduction Act, the Biden administration also has other plans to improve funding of hydrogen projects, promote electric vehicle charging, and the protection of public lands.[15] Tougher fuel economy standards, which were already included in executive orders, are also likely to receive buy-in from the auto industry, with companies like GM already committing to a fully electric fleet over the coming decades.[16]

Exhibit 3 – Carbon Neutral Policy Centers around the Globe



Source: Bloomberg New Energy Finance December 2020
Map Source: Wikimedia Creative Commons, Perhelion & TheSevenSeas, *World map longlat-simple.svg*

*Gross domestic product is a standardized measure of economic growth, measuring the sum of all goods and services produced by an economy

Investing in Clean Energy – an Equally-weighted Approach

As interest in the renewable energy space grows, more investors are seeking opportunities to invest. There are a plethora of thematic exchange-traded funds (ETFs) that provide this exposure, but we'd like to discuss specifically two main approaches: market-cap weighting and equally-weighting. In such a rapidly evolving sector, the equally-weighted approach could help investors tap into a wider opportunity set of emergent technologies.

One example is the WilderHill Clean Energy Index, the first clean energy index on the market, launched in 2004. The index starts by examining the renewable energy through six distinct sectors – **renewable energy harvesting** (turbines and panels that capture renewable energy), **energy conversion** (technologies that convert this energy into electricity – fuel cells, inverters, and more), **energy storage** (batteries and electric vehicles), **power delivery and conservation** (efficiency improvement and grid conditioning), **greener utilities**, and **cleaner fuels** (biodiesel, raw hydrogen production, etc.) After determining which pure-play stocks qualify in each sector, the sectors are weighted by their relative size, and stocks within each sector receive an equal weight.[17]

To show how this approach could potentially benefit investors, we will compare the WilderHill Clean Energy Index index to the S&P Global Clean Energy Index, a commonly quoted benchmark. By using a market-weighted methodology, the S&P index invested in 38.9% utilities at the end of August compared to 5.6% for the greener utilities sector in the WilderHill Clean Energy Index.[18] Utilities, especially in Europe, tend to have larger market caps, and by using a fundamentally-driven, equally-weighted approach, investors could access a more diverse set of technologies.

Conclusion

In the above paper, we attempted to provide an overview to the state of the renewable energy industry. As we have discussed, this is a space that is fundamentally about technology. Throughout the past two decades, renewable energy technology has continued to improve, setting the stage for broad implementation. At the same time, global policy has transformed since the early 2000s, and climate applications should continue to provide strong investment in these technology solutions in the coming decades. There are many ways to invest, but we have also attempted to show some of the potential benefits of an equally-weighted approach. As the technology continues to develop, new companies will continue to emerge as the economy transforms to meet a future that will hopefully be greener and brighter.

Endnotes:

1 Jérôme Fatet, *Recreating Edmond Becquerel's Electrochemical Actinometer*, Archives des Sciences, 2005
2 American Physical Society, April 2009
3 The Institute of Energy Conversion
4 Bloomberg L.P.
5 Frederico Caprotti, *Protecting innovative niches in the green economy: investigating the rise and fall of Solyndra, 2005-2011,* May 2016
6 Energy Sage, *How Solar Panel Cost and Efficiency Have Changed Over Time*, 2020
7 Statista, September 2022
8 Bernreuter Research, *Polysilicon Manufacturers, How the Ranking of the Top 10 Producers has Been Whirled Around Since 2004*, June 2020
9 Bloomberg New Energy Finance, December 2020
10 Hyundai Motors, August 2020
11 Bloomberg New Energy Finance, September 2022
12 Tim Lindsey, University of Illinois - RBC Thought Leadership, *Exploring Hydrogen Mobility*, January 2021
13 Bloomberg New Energy Finance, February 2021
14 Oxford University, June 2022
15 HSBC Global Research, "ESG Research", November 2020
16 General Motors, September 2022
17 WilderHill, September 2022
18 S&P Global Indices, December 31, 2020

Important Information

The WilderHill Clean Energy Index (ECO) seeks to define and track the Clean Energy sector: specifically, businesses that stand to benefit substantially from a societal transition toward use of cleaner energy, zero-CO2 renewables, and conservation. Stocks and sector weightings within the ECO Index are based on their significance for clean energy, technological influence and relevance to preventing pollution in the first place. We emphasize new solutions that make both ecological and economic sense, and aim to stay the leaders in this field.

The S&P Global Clean Energy Index is designed to measure the performance of 30 companies from around the world that are involved in clean energy-related businesses, comprising a diversified mix of clean energy production and clean energy equipment and technology companies.

An investment cannot be made into an index.

Companies discussed herein are not to be construed as buy/sell recommendations

About risk

There are risks involved with investing in ETFs, including possible loss of money. Index-based ETFs are not actively managed. Actively managed ETFs do not necessarily seek to replicate the performance of a specified index. Both index-based and actively managed ETFs are subject to risks similar to stocks, including those related to short selling and margin maintenance. Ordinary brokerage commissions apply. The funds are subject to certain other risks. Please see the current prospectuses for more information regarding the risks associated with an investment in each of the funds.

Investments focused in a particular industry, such as the clean energy, are subject to greater risk, and are more greatly impacted by market volatility, than more diversified investments.

The risks of investing in securities of foreign issuers can include fluctuations in foreign currencies, political and economic instability, and foreign taxation issues.

Shares are not individually redeemable, and owners of the shares may acquire those shares from the funds and tender those shares for redemption to the funds in creation units only, typically consisting of aggregations of 10,000, 25,000, 50,000, 75,000, 80,000, 100,000, 150,000 or 200,000 shares.

This does not constitute a recommendation of any investment strategy or product for a particular investor. Investors should consult a financial professional before making any investment decisions. Note: Not all products available through all firms.

Before investing, investors should carefully read the prospectus/summary prospectus and carefully consider the investment objectives, risks, charges and expenses. For this and more complete information about the Fund call 800 983 0903 or visit invesco.com for the prospectus/summary prospectus.

invesco.com/us

Invesco Distributors, Inc. 9/22 P-ETFCE-WP-1-E