



PGIM
India Mutual Fund

Investing in the Decarbonization Economy



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- Even by conservative estimates, capital investments to reduce greenhouse gas emissions are expected to be massive.
- The average cost of solar and onshore wind energy is lower than power from conventional sources, which is increasing demand for renewable energy and clean technology.
- To capitalize on the investment opportunity, we believe it is just as important to focus on companies aiding avoidance of global emissions as it is to focus on companies that reduce their own global emissions.
- Importantly, fossil fuels like oil, gas, and coal are not expected to be fully replaced as the transition to renewable energy unfolds—estimates suggest that these traditional sources of energy will simply grow at a slower rate.
- Innovative oil and gas companies can play a role in the decarbonization solutions and, in our view, those in the vanguard should be considered an important component of the overall investment opportunity set.

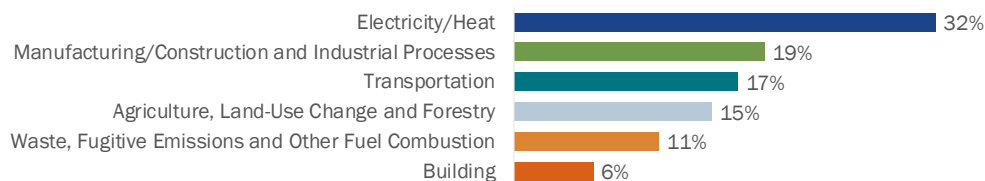
The Decarbonization Opportunity Is About Much More Than Energy and Transportation

Technological advancements, shifting consumer preferences, and regulations are leading countries and companies across the world to reduce carbon emissions and embrace sustainable practices. Even with limited further action or change, current policies suggest that the decarbonization economy will be massive.

This focus on decarbonization is transforming industries, creating a broad and growing opportunity set that we believe is underappreciated by many investors. The power and transportation sectors are among the top polluters, respectively accounting for 32% and 17% of global emissions (Exhibit 1). It follows that electric vehicles (EVs) and renewable energy have been popular areas of decarbonization discourse.

Exhibit 1. The Path to Net Zero Emissions Spans Industries

Global greenhouse gas emissions by economic sector, annual metric tons of carbon dioxide equivalent (MtCO₂e)



As of 2019.

Source: Climate Watch, the Organization for Economic Co-operation and Development (OECD), the International Energy Agency (IEA), and the Food and Agriculture Organization of the United Nations. Climate Watch data: Climate Watch GHG Emissions, Washington, DC: World Resources Institute. Available at: <https://www.climatewatchdata.org/ghg-emissions>. Agriculture, Land-Use Change and Forestry data supplied by the Agriculture Organization of the United Nations, FAO STAT Emissions Database. Fuel combustion data supplied by the OECD and IEA.

Authors

Neil Brown, CFA

Managing Director,
Portfolio Manager,
Global Natural Resources

Bobby Edemeka

Managing Director,
Portfolio Manager,
Income and Infrastructure

Jay Saunders

Managing Director,
Portfolio Manager,
Global Natural Resources

Abhi Kamerkar

Managing Director,
Client Portfolio Manager

Raj Shant

Managing Director,
Client Portfolio Manager

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However, decarbonization transcends EVs and energy. Areas such as agriculture, forestry, and other land use contribute nearly as much to global emissions as transportation. Meeting carbon-reduction goals requires an overhaul of existing infrastructure and the modernization of buildings and factories across the global supply chain. As this unfolds, demand for commodities like copper, a key input for electric vehicles and cleaner technology infrastructure, should surge. Fossil fuels are also expected to remain a significant part of the overall energy mix, creating opportunities for traditional energy companies that work to become part of the broader decarbonization solution, as they help to create the transition to a low carbon economy.

From an investment perspective, some of the decarbonization opportunity has been appropriately priced by the market in our view, with many companies fully valued—high profile renewable energy companies are one such example. However, we believe the broader market underappreciates the scope and duration of the decarbonization opportunity. As global efforts to reduce carbon emissions evolve, so will the opportunity set, and this should provide fertile ground for fundamental investors. In the following sections, we share our framework to help investors navigate and parse the breadth and depth of the investment universe.

Even Conservative Estimates Are Massive

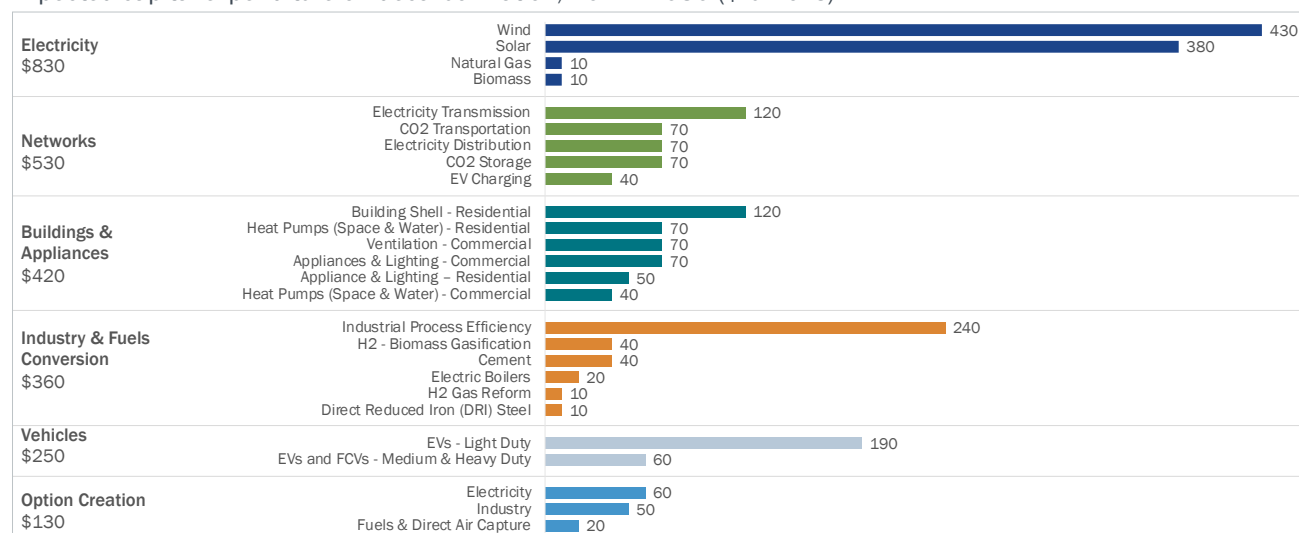
The scope of the multi-decade energy transition makes the decarbonization economy difficult to quantify. Variables in the public and private sectors, from policy setting to technological innovation and supply chains, can alter the opportunity set.

On the one hand, the International Renewable Energy Agency's "Ambitious Energy Transition Scenario" recommends total spending of \$110 trillion to effectively reduce greenhouse gas emissions.¹ With recent headlines focusing on the failure of countries to implement more aggressive carbon emissions measures, this number may seem far out of reach.

On the other hand, the International Energy Agency's (IEA) Stated Policies Scenario (STEPS) is a more conservative benchmark for future growth because it assumes that many governments will be unable to fully meet their currently stated climate objectives. Instead, STEPS assumes that only current policies and announced plans will be implemented. In this scenario, governments are not expected to implement additional policies beyond what they have already announced.

Exhibit 2. A Diverse Opportunity Set across a \$2.5T Addressable Market

Expected capital expenditure on decarbonization, 2021–2030 (\$ billions)



Source: Princeton Net Zero America Report, December 2020. <https://environmenthalfcenury.princeton.edu/>. Figures in 2018 billions (\$). Includes capital invested pre-financial investment decision (pre-FID) and capital committed to projects under construction in 2030 but in-service in later years. All values rounded to nearest \$10 billion and should be considered order of magnitude estimates. Incremental capital investment categories totaling less than \$5 billion excluded from graphic. Other potentially significant capital expenditures not estimated in this study include establishment of bioenergy crops and decarbonization measures in other industries besides steel and cement, non-CO2 greenhouse gas mitigation efforts, and establishing enhanced land sinks.

Even through the lens of the more conservative STEPS estimate, capital investments to reduce greenhouse emissions are expected to be massive. According to STEPS, spending on global clean energy is estimated to reach more than \$2 trillion a year by 2030, an increase of more than 50% from current levels.² And given the scope of greenhouse gas emissions across sectors, the investment opportunity set is expected to be broad based (Exhibit 2).

Competitive Costs Also Support the Decarbonization Economy

Government policy initiatives are not the only catalyst for the growth of the decarbonization economy. Demand from the private sector has soared in recent years as prices for renewable energy have plummeted over the past decade. Power from onshore wind now costs approximately \$46 per megawatt-hour (MWh), while electricity from large-scale solar plants costs \$45 per MWh.³ In comparison, new coal-fired plants cost \$74 per MWh, while gas plants are \$81 per MWh.³

As a result of declining costs, a growing number of US corporations and utility companies are buying power directly from wind and solar projects. As highlighted in Exhibit 3, companies like Google, Microsoft, and PepsiCo are among the ranks of US corporations completing wind and solar power purchase agreements.

The same study cited in Exhibit 3 shows that, as of January 23, 2023, the combined annual green power use of the Environmental Protection Agency's (EPA) top 100 partners amounts to nearly 85 billion kilowatt-hours, which, according to the EPA, is equivalent to the annual electricity use of nearly eight million average homes in the United States.

S&P Global expects annual copper demand to exceed 53 million metric tons by 2050, or more than the total copper consumed from 1900 to 2021.⁵

Commodity Demand to Surge

As capital is invested across the different areas of the decarbonization economy, a new set of raw inputs will enable the buildout of infrastructure and equipment. Whether it's solar panels, wiring, batteries, or auto parts, it starts with natural resources. This change is expected to amplify the importance of formerly esoteric commodities like lithium, cobalt, and chromium (Exhibit 4). For example, mineral usage in clean energy technologies is, on average, four to six times higher relative to conventional energy sources.⁴ Electric vehicles (EVs) require six to eight times more minerals than gas-powered vehicles.⁴

Exhibit 3. Lower Costs Support Growing Corporate Demand for Renewable Energy

EPA Partner	Annual Green Power (GP) Usage (kWh)	GP % of Total Electricity Use*	Industry	Green Power Resources
1. Google	9,100,267,846	105%	Technology & Telecom	Solar, Wind
2. Microsoft	8,324,914,969	100%	Technology & Telecom	Various
3. T-Mobile	7,806,076,868	100%	Technology & Telecom	Various
4. Walmart	5,023,096,337	28%	Retail	Various
5. Procter & Gamble	2,594,266,946	100%	Consumer Products	Various
6. AT&T	2,543,439,555	19%	Technology & Telecom	Solar, Wind
7. Apple	2,477,186,342	104%	Technology & Telecom	Biogas, Small-hydro, Solar, Wind
8. Equinix	2,458,915,894	100%	Technology & Telecom	Various
9. PepsiCo	1,887,793,706	103%	Food & Beverage	Solar, Wind
10. Kimberly-Clark	1,645,259,000	55%	Consumer Products	Solar, Wind

As of January 23, 2023.

Source: Environment Protection Agency (EPA). List is sorted by the U.S. organizations that use the most power from renewable sources. EPA Partners include a wide variety of leading organizations, including large corporations; small and medium-sized businesses; local, state, and federal governments; non-profit institutions; and colleges and universities. The Partnership provides a simple framework for organizations to exercise their choice in how their power is generated. For the full list of the EPA's top 100, please visit: <https://www.epa.gov/greenpower/green-power-partnership-national-top-100>.

* Reflects the amount of green power (GP) as a percentage of total electricity use. Partners choosing to purchase green power in an amount exceeding 100 percent of their U.S. organization-wide electricity use are listed as such.

Exhibit 4. Demand for Commodities in the New Clean Energy World Order

The relative importance of minerals and commodities for clean energy technology

	Copper	Cobalt	Nickel	Lithium	REEs	Chromium	Zinc	PGMs	Aluminum
Solar Photovoltaic	●	○	○	○	○	○	○	○	●
Wind	●	○	●	○	●	●	●	○	●
Hydro	●	○	○	○	○	●	●	○	●
Concentrating Solar Power	●	○	●	○	○	●	●	○	●
Bioenergy	●	○	○	○	○	○	●	○	●
Geothermal	○	○	●	○	○	●	○	○	○
Nuclear	●	○	●	○	○	●	○	○	○
Electricity Networks	●	○	○	○	○	○	○	○	●
EVs and Battery Storage	●	●	●	●	●	○	○	○	●
Hydrogen	○	○	●	○	●	○	○	●	●
● High ● Medium ○ Low									

As of May 2021.

Source: International Energy Agency (IEA), The Role of Critical Minerals in Clean Energy Transitions, World Energy Outlook Special Report. REEs = rare earth elements. PGM = platinum group metals. Aluminium demand is assessed for electricity networks only and is not included in the aggregate demand projections.

Traditional commodities like copper will also play a significant role. Given its durability and superior conductivity, copper is a key manufacturing input for electric vehicles, which need approximately 2.5 times as much of the metal as conventional cars.⁴ Due to its electrical conductivity and low reactivity, copper is also essential to the infrastructure needed to transport renewable energy, with uses that include cables, transistors, and inverters. According to S&P Global, copper demand will nearly double to 50 million metric tons by 2035.⁵ S&P Global expects annual copper demand to exceed 53 million metric tons by 2050, or more than the total copper consumed from 1900 to 2021.⁵

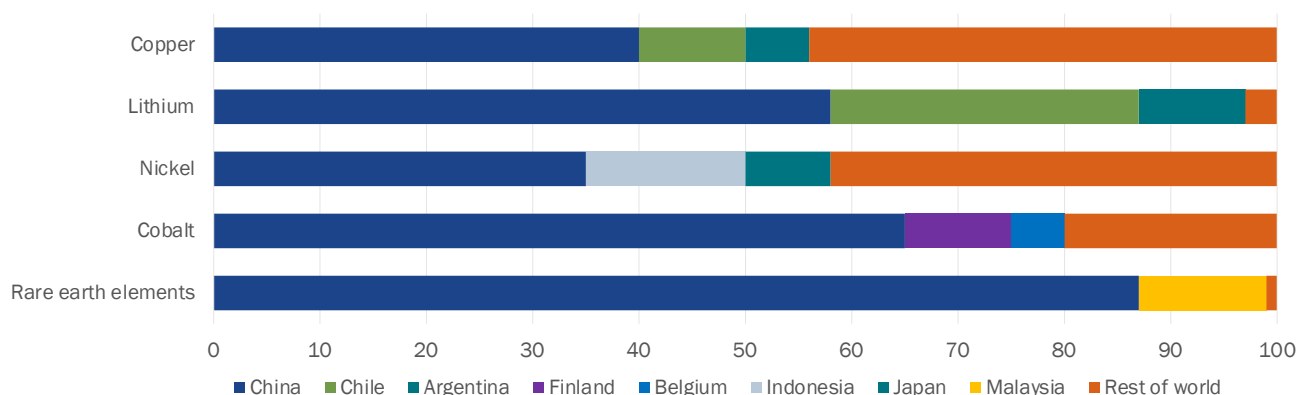
Geopolitics and Energy Independence

The increased focus on renewable energy sources has also raised strategic concerns about the global sources of related mineral extraction and processing, especially where they are located. For example, China is the number one producer of copper, nickel, cobalt, and lithium (Exhibit 5).

Given the increased strategic importance of raw materials, we believe there is a strong likelihood that governments will encourage future growth of onshore mineral supplies. This dynamic resembles the one behind the United States' recent increased onshore natural gas production (Exhibit 6). From an investment perspective, we expect this onshore focus to create opportunities in a new set of metals and mining companies.

Exhibit 5. New Supply Chain, New Opportunities

Share of processing volume by country for selected minerals

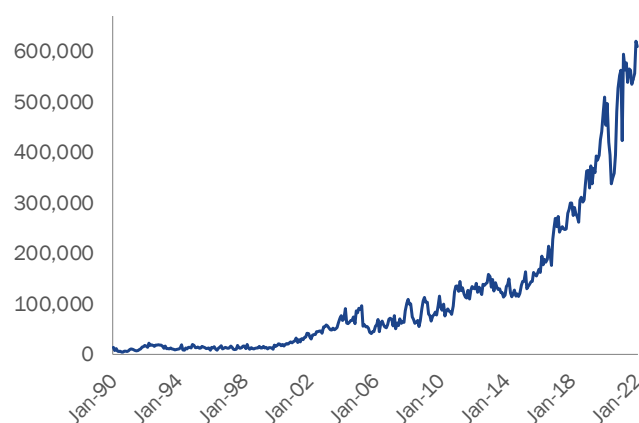


Latest available data as of October 2022.

Sources: International Energy Agency (IEA), World Bureau of Metal Statistics, and Adamas Intelligence for rare earth elements.

Exhibit 6. Global Demand for US Natural Gas Has Soared

U.S. Natural Gas Exports, million cubic feet



As of December 31, 2021

Source: Energy Information Administration

We expect the more progressive oil and gas companies to emerge as key components of broader decarbonization efforts as these more mature companies deploy their significant resources to stay ahead of sustainability trends and changes in the supply chain.

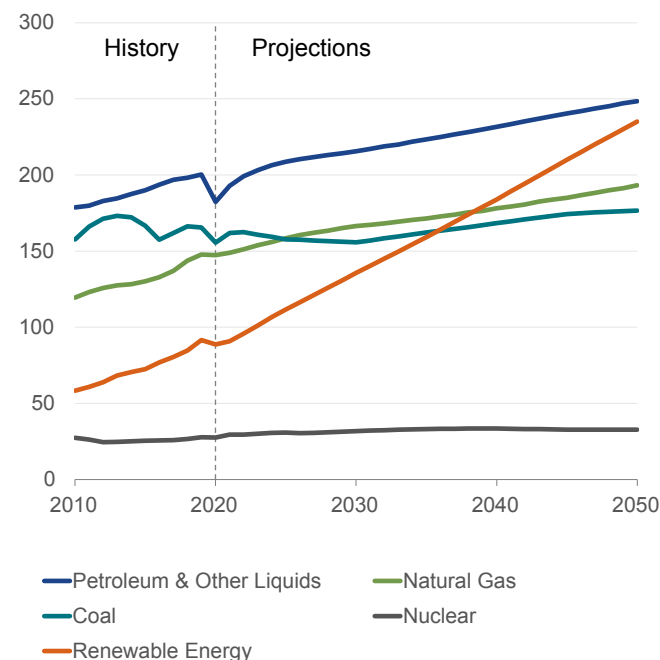
Fossil Fuels Are Not Going Away Anytime Soon

Decarbonization invites a conversation about energy transition, and for some investors, this may carry connotations that clean energy will displace fossil fuels, immediately and completely. While this may be desirable, it is highly unlikely. Fossil fuels like oil, gas, and coal are energy dense, require less new infrastructure to extract and store, and are abundantly available in fast-growing economies like China and India.

In addition, the buildout of infrastructure needed to support the growth of renewable energy is massive and will require years of significant investment. As a result, some estimates suggest that demand for traditional energy sources will simply grow at a slower rate (Exhibit 7).

Exhibit 7. Fossil Fuels Are Projected to Remain a Key Part of the Energy Mix

Global primary energy consumption by source, British thermal units, quadrillions



As of June 2022

Source: US Energy Information Administration. Annual Energy Outlook 2021. Most recent data available. Note: petroleum and other liquids includes biofuels, and electricity generation from renewable sources is converted to Btu at a rate of 8,124 Btu/kWh. Provided for illustrative purposes only. Forecasts may not be achieved and are not a guarantee or reliable indicator of future results. Although Jennison believes that the expectations reflected in such forward looking statements are based on reasonable assumptions, actual results may differ materially from those projected

Hydrocarbon Producers: The Problem... and Potentially Part of the Solution?

Large integrated energy companies that are global conglomerates with significant scale and project-management capabilities currently dominate the energy industry. We expect the more progressive oil and gas companies to emerge as key components of broader decarbonization efforts as these more mature companies deploy their significant resources to stay ahead of sustainability trends and changes in the supply chain. Given the complexity of new alternative energy projects, these companies have the knowledge, expertise, and balance sheets to successfully execute multi-year alternative energy projects. Accordingly, we see fossil fuel companies playing an important role in decarbonization and participating in the overall investment opportunity set.

A Framework for Understanding the Investment Opportunity

Given the massive scope of decarbonization efforts, Jennison has developed a framework to help investors understand and quantify the opportunity set. From an investment perspective, we believe the companies best positioned for the decarbonization economy fall into three key categories: supply, demand, and enable (Exhibit 8).

Supply

The supply category includes companies that harness and/or produce lower- or zero-emissions fuels with the ultimate goal of replacing fossil-fuel power generation with clean sources. Among renewable energy sources, wind and solar markets are relatively more mature. However, in response to the conflict in Ukraine, Europe, which is among the largest consumers of Russian-supplied oil and gas, accelerated efforts to diversify its sources of energy. As a result, Europe has fast-tracked the roll-out of renewable gases like renewable hydrogen. In addition, the technology required to improve efficiencies and costs, as well as store alternative sources of energy like wind, solar, and hydrogen, is expected to advance over time.

Demand

Companies in the demand category promote energy efficiency across industrial applications and buildings and by deploying energy storage. Demand-oriented companies also focus on retrofitting existing infrastructure. The construction sector accounts for nearly 50% of annual global CO₂ emissions and, in 2040, approximately two-thirds of global buildings will be structures that exist today.⁶ Modernizing the world's commercial and residential buildings is an enormous undertaking that will require significant investment.

Enable

Enablers provide technological innovations, equipment, infrastructure, materials, goods, and services that enhance power processing capabilities and create intelligent infrastructure. Examples of enablers include companies that support the creation of new power grid architecture and infrastructure needed to support electric vehicles. These include electric charging stations, metering, and transmission, which are expected to grow significantly. In 2017, there were between 50,000 and 70,000 Level 2 ports⁷ in the United States (the typical charging station for electric vehicles). In 2021, the number of Level 2 ports grew to roughly 90,000.⁸ To meet expected demand for electric vehicles, the number of charging stations needs to increase to between 2,230,000 and 2,240,000 by 2025.⁷

Enablers also include companies specializing in the materials required to develop wiring across the power transmission grid. For example, updating the current power transmission infrastructure will require heat-resistant, water-proof cables. Recently, these cables helped create the world's longest submarine electricity interconnector between the United Kingdom and Norway,⁹ which enabled the sharing of renewable energy between the two countries for the first time.

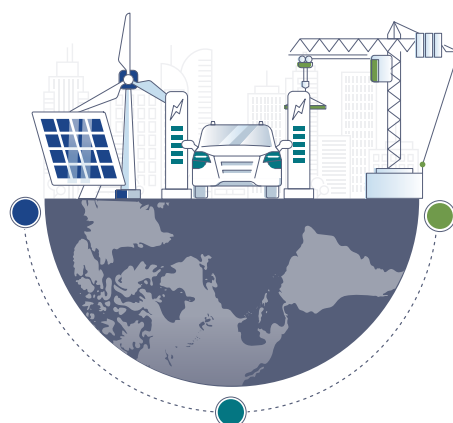
Exhibit 8. Understanding Decarbonization Opportunities at the Company Level

The pursuit of carbon reduction goals is altering industries and creating a diverse opportunity set that is underappreciated by many investors. We believe the companies best positioned for the new decarbonization economy fall into three categories:

SUPPLY

Companies that harness and/or produce lower- or zero-emissions fuels with the ultimate goal of replacing fossil-fuel power generation with clean sources.

- Renewables
- Electricity Generation
- Natural Gas
- Wind Turbine Manufacturers



ENABLE

Companies that provide technological innovations, equipment, infrastructure, materials, goods, and services that enhance power processing capabilities and create intelligent infrastructure.

- Technologies
- Battery Reuse and Recycling
- Power Grid Architecture

DEMAND

Companies that improve the energy efficiency of existing infrastructure and replace fossil fuels in industrial processes.

- Industrial Applications
- Energy Efficiency & Storage
- Fuel Replacement
- Smart Buildings

Source: Jennison. For illustrative purposes only.

What Else Are Investors Missing?

Everything we have covered so far suggests that many people could be underestimating the decarbonization investment opportunity. There is one additional issue that we believe is important that tends to be overlooked: carbon emissions avoided.

Most investors, regulators, and policymakers focus on the operational emissions of companies, which are often referred to as direct emissions, or “Scope 1, 2, and 3 emissions” in industry terms. In this framework, stakeholders want to know: How high are these emissions, what were they last year, and will they go down next year? This perspective completely misses a whole subset of companies that are doing just as much, if not more, to aid the decarbonization effort, but that are not captured as they exist outside this framework.

Consider the example of a company that advises other organizations on how to reduce and avoid energy usage and, thus, its emissions. On its own, this consultancy has low operational emissions, which means it has little room to improve its carbon footprint in a way that would attract traditional decarbonization investment capital. However, based on the emissions this company helps to avoid (what many call “Scope 4 emissions”), it could be a significant contributor to the decarbonization effort and a worthwhile investment candidate.

As a result of prevailing frameworks and Net Zero focus, investment interest has tilted toward more mature wind and solar companies, as well as renewable developers and companies that produce batteries and smart metering. While less mature companies in the decarbonization economy are currently limited by a lack of commercial viability and immature end markets, expanding the investment opportunity set to include them can be a better recipe for delivering attractive growth over time, in our view.

Change Creates Opportunities

We believe the decarbonization economy represents a significant opportunity for long-term investors to generate alpha across a broad spectrum of sectors. We expect the pursuit of carbon-reduction goals to drastically alter a wide range of industries, including electricity generation and transmission, building infrastructure, vehicles, forestry, and agriculture. We believe this will lead to a rich and diverse opportunity set as decarbonization initiatives and policies play out over multiple decades.

At the same time, we do not expect fossil fuels to be fully replaced. Renewables, while rapidly growing, are still a relatively small part of the current energy mix and, as the energy transition unfolds, an “all of the above” approach to energy production will be needed to meet demand affordably.

Endnotes

- ¹ June 2021
- ² IEA, World Energy Outlook, October 27, 2022
- ³ Bloomberg, Renewable Power Costs Rise, Just Not as Much as Fossil Fuels, June 30, 2022
- ⁴ IEA, The Role of Critical Minerals in Clean Energy Transitions, World Energy Outlook Special Report, May 2021
- ⁵ S&P Global, Copper on the Rise, July 14, 2022
- ⁶ Architecture 2030, US Energy Information Administration, Global Status Report 2021
- ⁷ Copper Development Association, Copper Drives Electric Vehicles 2017
- ⁸ EVAdoption and Alternative Fueling Data Center December 31, 2021
- ⁹ Prysmian Group, Prysmian completes North Sea Link, the world's longest submarine electricity interconnector, ahead of schedule March 16, 2022

Disclosures

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