



CLEAN ENERGY INVESTMENT IMPLICATIONS

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This research report reviews the impact of the movement toward clean energy on economic activity and the major long-term investment implications.

With concerns mounting about the human influence on climate change, the importance of clean energy to the economy continues to grow. According to a poll by Pew Research, two-thirds of American adults say the U.S. should prioritize developing alternative energy sources, suggesting that the acceleration toward clean energy is sustainable.

Given rising geopolitical tensions, a critical element in favor of clean energy is that it provides a pathway toward energy independence. Russia's invasion of Ukraine exposed Europe's economy to a shock due to its dependence on Russian natural gas and highlighted the urgency to develop alternative energy sources. China is a major importer of traditional energy, and clean energy is an important part of its goal of energy independence. While shale drilling has enabled U.S. energy independence, shale hydrocarbons are a depleting asset, and clean energy will play a critical role in maintaining future U.S. energy independence.

CLEAN ENERGY DEFINED

Clean energy is produced through methods that do not release greenhouse gases or other pollutants. It is often referred to as renewable energy since many forms of clean energy are renewable, including solar, wind, water, geothermal, and bioenergy.

Nuclear power is an important clean energy source since it does not emit carbon dioxide (CO₂) and is well suited for the base-load generation needed due to the cyclical nature of solar and wind power generation. Consequently, we see nuclear power playing a key role in reducing greenhouse gases.

MAJOR SOURCES & USES OF ENERGY

Energy is at the heart of economic activity, and understanding the major sources of energy demand and supply is critical for understanding the economic impact of reducing carbon emissions.

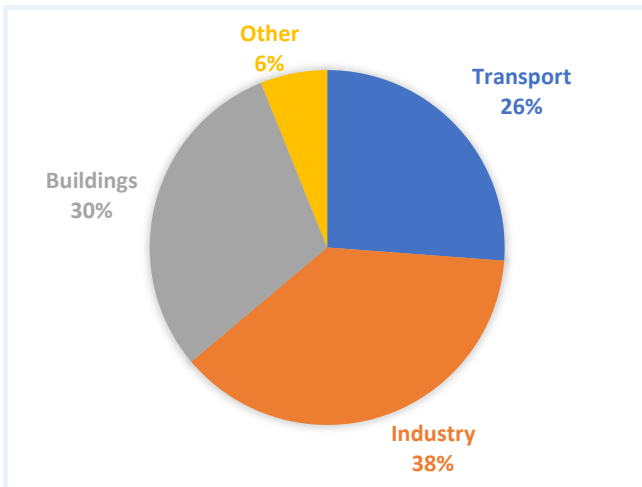
The Paris Agreement on Climate Change

On his first day in office, President Biden rejoined the Paris Agreement on climate change. Most Americans still favor the U.S. taking steps to become carbon neutral by 2050, according to recent Pew Research surveys. The agreement has the primary goal of keeping global temperatures below 2 degrees Celsius (3.6 Fahrenheit) above pre-industrial times and reaching net-zero carbon emissions by the middle of this century (limiting the amount of greenhouse gases (GHG) emitted by human activity to the same levels that trees, soil, and oceans can absorb naturally).

The Paris Agreement was originally adopted by nearly 200 countries in 2015 and went into effect in 2016. The centerpiece of the agreement is a set of pledges made by participating countries, known as Nationally Determined Contributions (NDCs), to near-term GHG targets they plan to achieve. The pledges have been reaffirmed with increasing urgency at the yearly UN Climate Change Conference of the Parties. These national climate action plans are leading to policy decisions with major economic and investment implications.

The major contributors to energy demand, and consequently CO2 emissions, include transportation (26%), industry (38%), and buildings (30%). Transportation includes powering passenger cars, trucks, trains, planes, and ships. Industry includes things we make, with energy use concentrated in metals (iron and steel), cement, chemicals, and manufacturing. Buildings includes heating, cooling, and lighting of residential and commercial real estate.

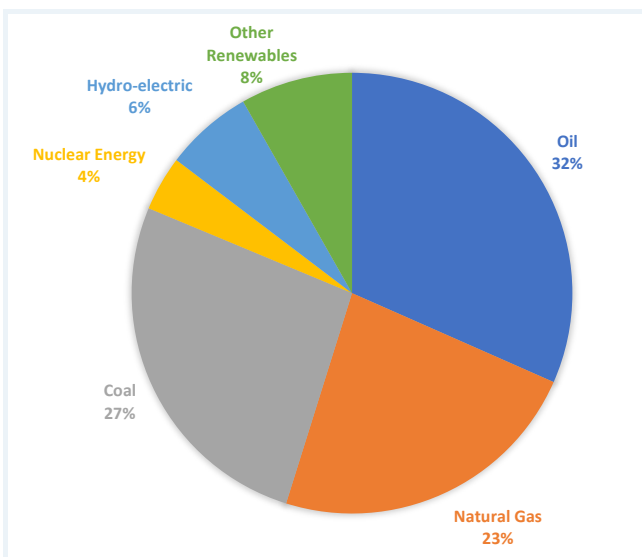
Chart 1: Energy Demand—2023



Source: International Energy Agency (IEA) and Energy Institute

The primary source of energy remains fossil fuels, with oil (32%), natural gas (23%), and coal (26%) comprising 81% of current energy supply. While renewables, including nuclear (4%), hydro (6%), and other renewables—primarily wind and solar (8%)—only make up 18% of supply, they are rapidly gaining share as climate change concerns mount and their cost becomes more competitive with traditional fossil fuels.

Chart 2: Energy Sources—2023



Source: International Energy Agency (IEA) and Energy Institute

ACCELERATING GROWTH OF RENEWABLE ENERGY SOURCES

According to the International Energy Agency (IEA), the adoption of clean energy technology surged at an unprecedented pace from 2020 to 2022. Solar PV capacity additions increased by nearly 50%. Electric car sales expanded by 240%, and stationary battery installations have expanded by 200% since 2020. The IEA now estimates that global manufacturing capacities for solar PV and electric vehicle batteries would be sufficient to meet projected demand in 2030 in its net-zero emissions by 2050 scenario if announced projects proceed.

The progress reflects cost reductions for key clean energy technologies—solar PV, wind, heat pumps, and batteries—which fell nearly 80% on a deployment-weighted average basis between 2010 and 2022. IEA predicts a further acceleration in the scale-up of the clean energy transition through the rest of this decade. Importantly, clean energy is set to see decades of secular growth to meet current carbon-reduction pledges.

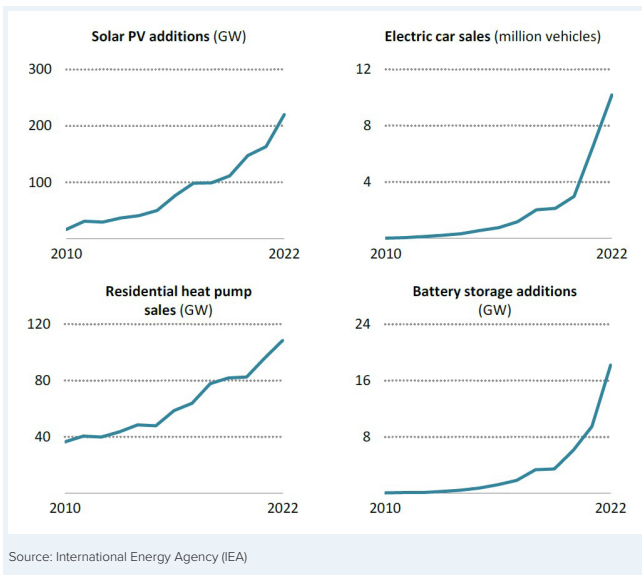
Importance of Environmentally Conscious Investing

Environmental, Social, and Governance (ESG) investing (also referred to as sustainable, responsible, and impact investing or socially responsible investing) is an influential investment discipline. A cornerstone of this investment approach is the environmental criteria, which looks at how a company performs as a steward of the natural environment—a key element is the firm’s impact on climate change or carbon emissions. ESG and other major shareholders, including pension funds and large asset management firms, are increasingly forcing firms to address their impact on the environment.

CORPORATIONS BUYING SIGNIFICANT CLEAN ENERGY

With corporate concerns over climate change (and pressure from shareholders to reduce their carbon footprint), corporations are increasing their purchases of clean energy. A corporate power purchase agreement (PPA) is a long-term contract under which a business agrees to purchase electricity directly from an energy generator. Corporate power procurement had another record-breaking year in 2023, with 46 gigawatts (GW) of solar and wind contracts, a 12% year-on-year increase over the previous record in 2022. This was helped by the declining costs of clean energy. While the United States remains the world’s largest PPA market, Europe saw its corporate PPA volumes grow 74% to 15.4GW—by far the largest growth of any region.

Chart 3: Accelerating Global Installations of Clean Energy Technologies Since Paris Agreement in 2015



THE INFLATION REDUCTION ACT OF 2022 (IRA)

The U.S. Inflation Reduction Act of 2022 is arguably the most comprehensive and impactful legislation to be implemented on cleantech. It unlocks incentives that make most clean tech technologies profitable at large scale, across both renewable electrons (solar, wind, EVs, energy storage) and renewable molecules (bioenergy, clean hydrogen, carbon capture).

The law features \$369 billion in spending and tax incentives on energy and climate change provisions. Most of these energy security and climate-related provisions take the form of tax credits that, among other things, encourage reduced reliance on fossil fuels or increased conservation. There are some programs that are direct federal spending or grants and loans.

Ultimately, analysts expect U.S. government direct spending and tax credits under the law will far exceed the initial \$400 billion estimate, with some estimates projecting up to \$1.2 trillion of spending through 2031.

Critical Initiatives Required to Lower Emissions

To meet the Paris Agreement's pledge to lower carbon emissions to net zero by mid-century requires several key initiatives.

Energy Efficiency:

A critical contribution to reducing emissions is increased energy efficiency, or reducing energy intensity. Energy efficiency is one of the most cost-effective means of lowering carbon emissions and is essential to any net-zero carbon scenario. In addition, many efficiency measures in industry, buildings, appliances, and transportation can be put into effect and scaled up very quickly. Studies show that increased use of digital technologies has significant potential to increase efficiency and productivity.

Increased Electrification with Decarbonized Grid:

International Energy Agency (IEA) research calls for scaling up solar and wind rapidly this decade to get to net-zero carbon emissions by 2050. Its roadmap requires reaching annual additions of 820 gigawatts (GW) of solar photovoltaics (PV) and 350 GW of wind by 2030. This compares to the record 220 GW of solar capacity added in 2022 and is equivalent to installing the world's largest solar park roughly every day.

The IEA also states that hydropower and nuclear—two of the largest sources of low-carbon electricity today—provide an essential foundation for transitions, with both well positioned for generating base-load power (the minimum amount of electric power needed to be supplied to the electrical grid at any given time). As the electricity sector becomes cleaner, electrification emerges as a crucial economy-wide tool for reducing carbon emissions. As an example, electric vehicles (EVs) go from around 15% of global car sales to more than 65% by 2030, under IEA's net-zero scenario.

Further Innovation:

Reaching net zero by 2050 requires further rapid deployment of available technologies as well as widespread use of technologies that are not on the market yet. Major innovation must occur to bring these new technologies to market. These technological breakthroughs are critical for certain industries, including heavy industry and long-distance transport, to make the transition.

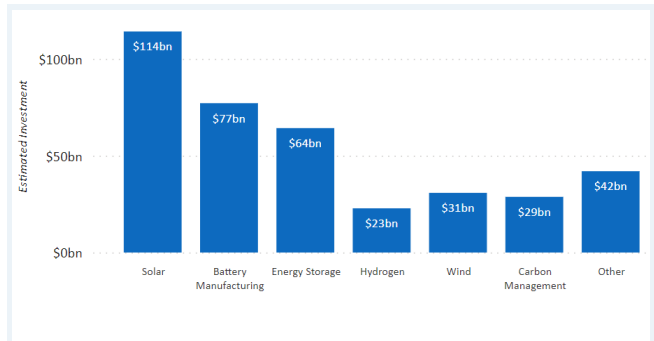
The biggest innovation opportunities concern advanced batteries, hydrogen electrolyzers (renewable systems that convert water into hydrogen and oxygen, which can then be used as clean fuel), and direct air capture and storage (carbon capture and sequestration). Together, these three technology areas are projected to make vital contributions to reducing future CO2 emissions. These innovations will also require large-scale construction of infrastructure, including new pipelines to transport captured CO2 emissions and systems to move hydrogen around and between ports and industrial zones.

Two years after the passage of the Inflation Reduction Act, companies have announced more than \$380 billion in new investments to build the clean energy economy, according to Rhodium Group and MIT's Clean Investment Monitor (CIM). This includes investments in industries like electric vehicles, batteries and energy storage, clean energy manufacturing, clean power generation, carbon management, and many others, according to data tracked by Rhodium Group and MIT's Clean Investment Monitor.

CLEAN ENERGY NOW LEADS INVESTMENT FLOWS

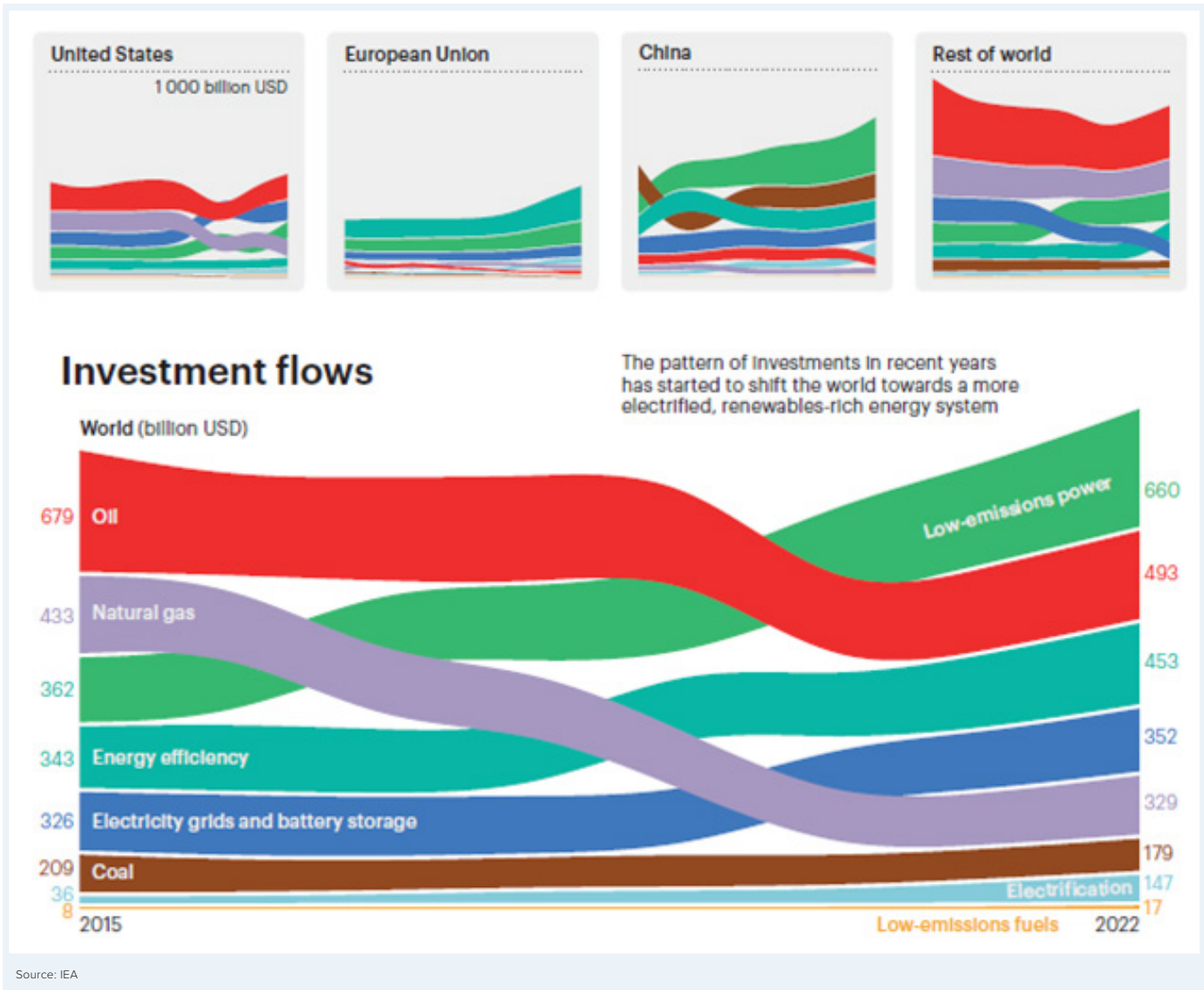
There is an acceleration in clean energy transitions occurring across the globe. The deployment trends for solar PV, electric vehicles, batteries, and heat pumps are significant,

Chart 4: Announced IRA Investments by Technology: Over \$380 Billion are being Invested in a Range of Technologies



Source: Rhodium Group/Clean Investment Monitor (CIM)

Chart 5: Significant Global Spending for Transition to Clean Energy



and the overall balance of investment is shifting toward clean energy. For every \$1 spent on fossil fuels, \$1.8 is now spent on a range of clean energy technologies and related infrastructure: five years ago, this ratio was 1:1. The increase in spending is concentrated in advanced economies and China.

ENERGY STORAGE WILL PLAY A KEY ROLE

Energy storage will play a key role in supporting the development of renewables. Batteries and hydrogen will become critical parts of the electrical grid. Smart grid technologies will also be needed to allow electric vehicles (EVs) and other devices to be used for energy storage and management.

While some sectors of the economy can easily transition to using electricity instead of fossil fuels, other activities are not amenable to electrification and will require other sources of clean energy.

HYDROGEN WILL PLAY AN IMPORTANT ROLE

Described by the IEA as a “versatile energy carrier,” hydrogen has a diverse range of applications and can be deployed in sectors such as industry and transportation where battery use is not very feasible. It can be produced in a number of ways. One method includes electrolysis, which is an electric current that splits water into oxygen and hydrogen. If the electricity used in the process comes from a renewable source, such as wind or solar, then it is considered “green” or “renewable” hydrogen. Currently, the vast majority of hydrogen generation is based on fossil fuels, and “green” hydrogen is expensive to produce.

Hydrogen is increasingly emerging as a potential solution to provide both energy storage to support electrification and the ability to be burnt directly in areas that are hard to electrify, such as heating, long-haul transport (trucking and aviation), and steel and cement production. Governments and companies are committing substantial resources toward hydrogen, and future innovation for clean hydrogen production is critical for reaching net-zero emissions by mid-century.

IMPORTANCE OF BIOFUELS

Biofuels consume CO₂ as they grow, so they are considered an important clean energy source. With concerns over higher food prices, deforestation, and land-use conflicts, attention is moving away from first-generation, crop-based biofuels. The focus is now on new second-generation biofuels that can be manufactured from raw waste materials and are preferred by policymakers. These include used cooking oil, animal fats, and agricultural residues. Bio-liquids make up close to 5% of transportation demand today, with estimates showing growth to 20% by 2050, with aviation and trucking most likely seeing increased use.

IMPACT ON ECONOMIC SECTORS & INVESTMENT IMPLICATIONS

Climate change concerns and the growth of ESG investing (and its emphasis on the environment) are causing publicly traded companies to focus on reducing their carbon footprint. Major asset managers, which have signed a pledge supporting goals to reach net-zero carbon emissions by 2050 or sooner, are under pressure to exert influence on their portfolio companies to do more about climate change. Major pension funds are also increasingly voting to hold companies accountable for their impact on the environment.

These initiatives are forcing companies from all economic sectors to increase efficiency, utilize clean energy, or modify their business models to reduce their carbon footprint.

However, the biggest impact of the movement toward clean energy is being felt in the Energy, Utility, Material, and Industrial sectors of the economy.

Energy

Solar and wind energy producers are set for significant growth in the coming years, with low-cost producers well positioned.

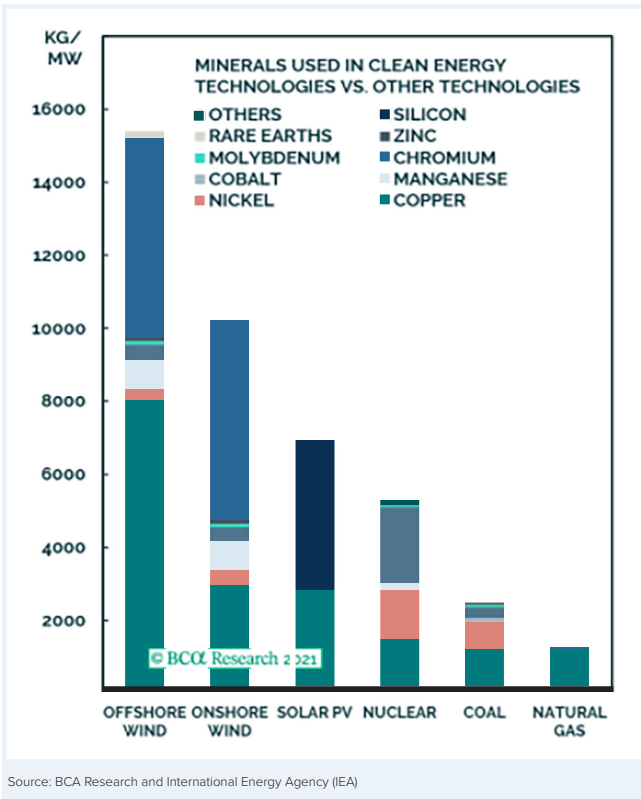
With its ability to produce power when the sun does not shine, and the wind is not blowing, nuclear energy will have a key role to play in a low-carbon future, especially for base-load purposes (minimum amount of electrical power needed for the electrical grid, which is important due to wind and solar power variability).

While traditional oil and gas firms are being pressured by major shareholders to show they can transition their business models to a low-carbon world, traditional energy sources will be in demand for the foreseeable future. Fossil fuels meet 81% of today’s energy demand, and oil and gas firms remain critical to the economy, providing a flexible source of power with diverse applications.

Ironically, significant fossil fuel energy will be needed to produce all the materials to transition to a low-carbon world (more about this under “Materials”). Moreover, major oil companies are developing carbon-capture and sequestration systems and making their own investment in clean energy, which should help them transition to a low-carbon world.

In the long term, natural gas will continue to play a key role in energy production, considering it produces less carbon relative to other fossil fuels and can be used for base-load electricity generation.

Chart 6: Accelerating Global Installations of Clean Energy Technologies Since Paris Agreement in 2015



Materials

Studies by the World Bank and IEA point to a significant demand for base metals and other materials needed to transition to clean energy. A typical electric car requires six times the mineral inputs of a conventional car, and an onshore wind plant requires nine times more mineral resources than a gas-fired power plant. Since 2010, the average amount of minerals needed for a new unit of power-generation capacity has increased by 50% as the share of renewables has risen.

The types of mineral resources used vary by technology. Lithium, nickel, cobalt, manganese, and graphite are crucial to battery performance, longevity, and energy density. Rare earth elements are essential for permanent magnets that are vital for wind turbines and EV motors. Electricity networks need a huge amount of copper and aluminum, with copper being a cornerstone for all electricity-related technologies.

The accelerating shift to a clean energy system is driving a huge increase in the requirements for these minerals, meaning the Energy sector is emerging as a major force in mineral markets. Until the mid-2010s, the Energy sector represented a small part of the total demand for most minerals. However, as energy transitions accelerate, clean energy technologies are becoming the fastest-growing segment of demand.

In an IEA scenario that meets the Paris Agreement goals, clean energy technologies' share of total demand rises significantly over the next two decades to over 40% for copper and rare earth elements, 60-70% for nickel and

cobalt, and almost 90% for lithium. EVs and battery storage have already displaced consumer electronics to become the largest consumer of lithium and are set to take over from stainless steel as the largest end-user of nickel by 2040.

Metal and mining firms are well positioned for surging demand that is set to last decades.

Utilities

Utilities are seeing a fundamental change to their business model as a result of clean energy requirements. The majority of U.S. utilities now have net-zero emission equivalent targets or are taking significant steps to comply with their state's clean energy mandates.

Historically, utilities pass through to retail customers the cost of fossil fuel used to generate electricity (typically 40-50% of a typical bill). With renewable energy, customers do not pay a fuel charge but pay a cost that allows utilities to recapture their investment in renewable generation.

This investment is projected to be substantial in the coming years and includes higher required supporting natural gas generation and battery storage installations to accommodate base-load requirements and offset increased variable renewable supply.

Investment in the electric grid is also projected to be massive due to substantially higher electricity usage. Electrifying the Transportation sector significantly increases demand. In addition, estimates show that the electrification of residential natural gas needs would require U.S. states to, on average, double the size of their electric grid.

Consequently, higher investment is causing many utilities to see their long-term earnings growth rates increase, which should benefit the valuation they are given by market participants.

Industrials

Many industrial firms are involved in commodity extraction, transportation, and improving energy efficiency. They are directly involved in and impacted by the movement toward clean energy, with many well-positioned for the transition.

Technology

From providing software and semiconductors necessary for advanced transportation and power grids to power their server farms with clean energy, many tech firms are well-positioned to transition to clean energy. Semiconductors are at the heart of solar power, with many solar stocks classified as Technology stocks.

Please contact your Janney Financial Advisor for additional details and actionable investment ideas.

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