

EXECUTIVE SUMMARY

FUELING THE FUTURE

Investing Across the Global Energy Landscape

Introduction

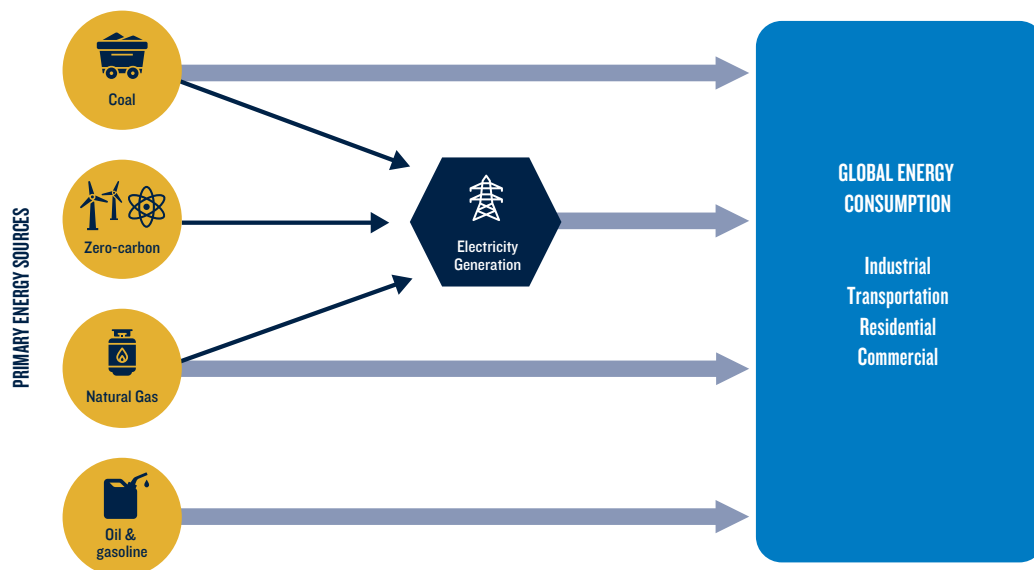
Nations have risen and fallen, governments come to power and been ousted, and businesses created and destroyed, all in the quest for energy. Today we stand at another critical inflection point for the energy system. For long-term investors, navigating this unprecedented and uncertain energy landscape is critical for four key reasons:

1. **Energy not only accounts for 10% of the global economy but is also a crucial input into the remaining 90%.**
Energy prices drive key macroeconomic indicators including inflation, consumer spending, economic growth and external balances.
2. **Establishing and maintaining dependable access to energy lies at the heart of many geographical fault lines.** These geopolitical risks are critical for understanding sovereign risk, evaluating potential capital

restrictions and monitoring country-specific risk factors across the portfolio.

3. **The energy transition – the shift towards electrification and a low-carbon energy mix – creates an array of attractive investment opportunities,** leads to obsolescence risk in waning energy sectors that may be over-represented in investors' portfolios, and requires vigilance against overhyped innovations that in reality are often too distant, uneconomic or politically unfeasible.
4. **For investors with ESG goals, the inescapable arithmetic of global energy supply and demand means fossil fuels will remain a major source of energy supply for decades to come.** Such a world requires considerable investment nuance – and a simplistic strategy that divides the world into brown villains and green heroes will not be the most effective approach to achieve either environmental or fiduciary objectives.

The energy system – a simplified schematic



Note: A small portion of oil is used for electricity generation and some renewables are directly used within sectors.
Source: PGIM Thematic Research.



The New Energy Landscape

To meet our seemingly insatiable demand, the energy system has become ever more complex, adding an array of new energy sources that supplement rather than completely replace legacy fuel sources. Today our energy system sits at a critical inflection point – and while it will take decades for every contour of this new energy landscape to be fully realized, several foundational themes are emerging.

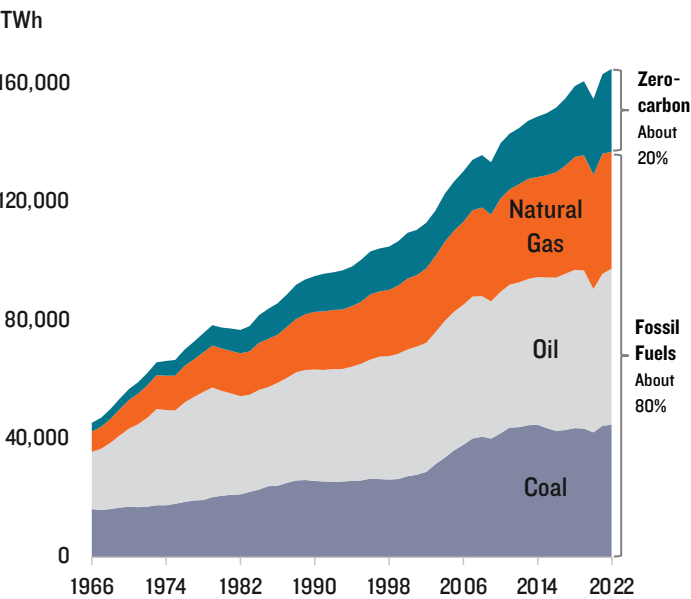
1. With rising geopolitical tensions, energy security is national security

It is difficult to overstate the primacy of ensuring a secure and reliable supply. When considering energy security, it is important to note each country faces a unique landscape. Because of its importance, access to primary energy sources will be a key factor in the pace of the energy transition away from fossil fuels.

2. Our reliance on fossil fuels will continue for decades, even amidst the energy transition

Our global economy has evolved over decades with fossil fuels as the primary source of energy. They currently provide 80% of global energy and are likely to remain a significant component of supply for decades.

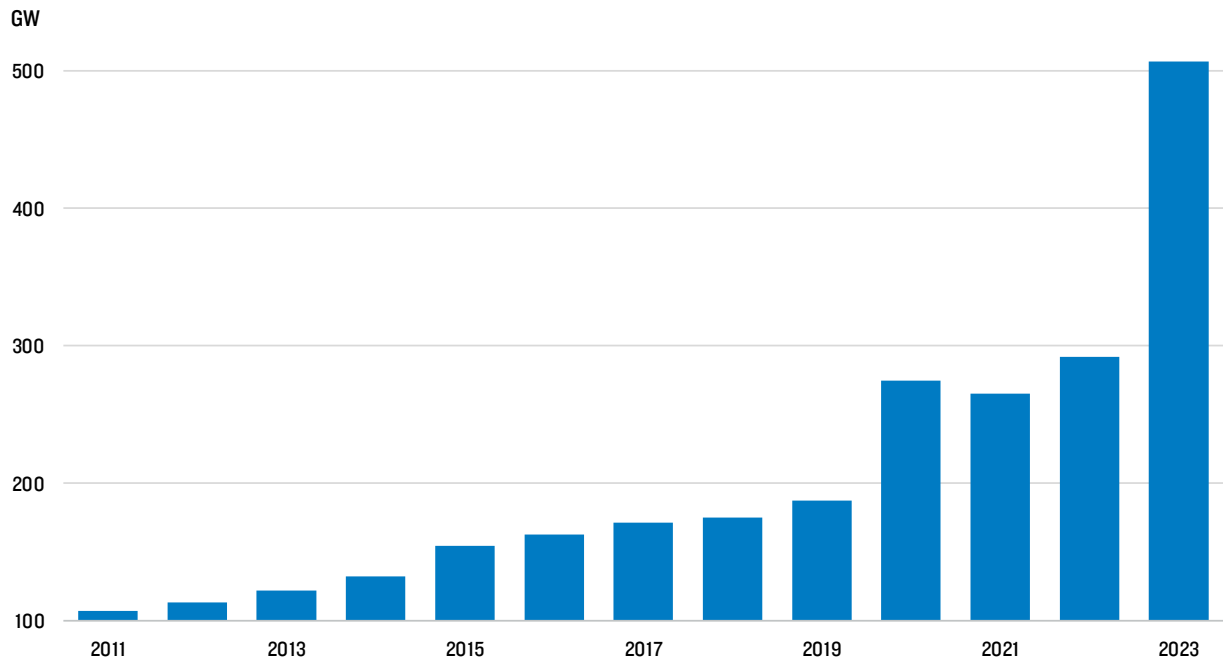
Fossil fuels power today's world
Energy consumption by primary source, terawatt hours



Note: Zero-carbon includes solar, wind, biofuels, hydropower and nuclear.
Source: US Energy Information Administration, Global Energy Outlook 2023. March 2024.

Renewable power is skyrocketing

New renewable electricity generation added globally, gigawatts



Source: International Energy Agency and International Renewable Energy Agency. March 2024.

There are multiple economic and political reasons for the persistent significance of fossil fuels, but three factors are often underappreciated in discussions on the pace of the energy transition. First, there are many specific uses where renewables may not offer a complete substitute for fossil fuels, for example in steel manufacturing or in powering airplanes and ships. Second, the elaborate global infrastructure network for fossil fuels provides a huge incumbency advantage over renewables. Third, permitting issues and NIMBYism contribute to a lack of capital for critical renewable infrastructure.

3. A major transition is underway – with electrification at the center of it

Previous energy transitions – from wood to coal in the 18th century and from coal to oil in the early 20th century – have unfolded slowly, often over a century or more. A major transition has now been underway for two decades from fossil fuels to lower-carbon sources, driven by climate change concerns, government subsidies and regulations, technological innovations, and lower costs of renewable energy production.

4. Stark tradeoffs around electrification will determine the pace of the energy transition.

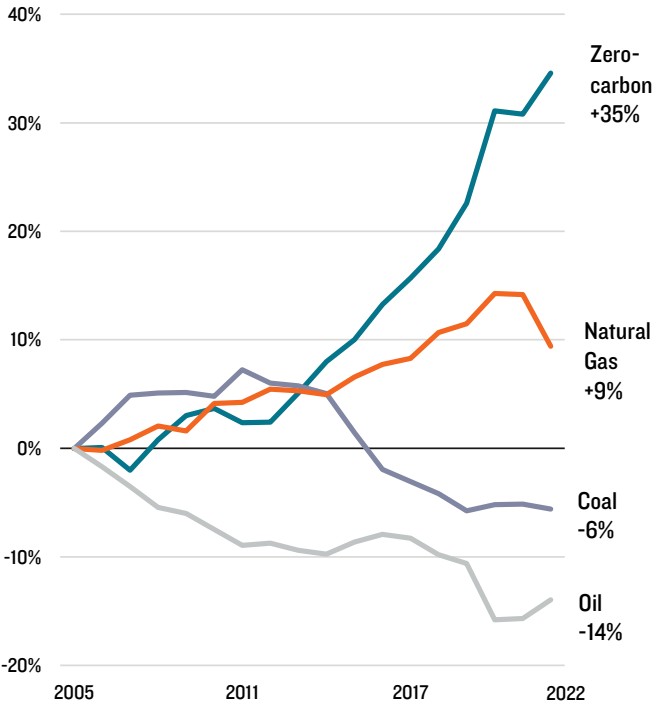
An optimal energy system would not only have secure access to primary sources and key components, but would also provide electricity cheaply when it is most needed and without harming the environment. What is often ignored is that: *no single source of electricity is optimal across all three fronts*. That is, fossil fuels and zero-carbon sources present different tradeoffs across:

- **Dispatchability** – technical jargon for the ability to generate power when it is needed, i.e., how easily power production can be turned up or down to meet variations in demand.
- **Affordability** – few developments can trigger universal political backlash quite like rising energy and electricity prices. Consequently, governments and politicians have very little incentive to compromise on energy affordability. Increasingly, renewables have become the cost-effective way of generating electricity.
- **Carbon emissions** – energy – both its production and consumption – accounts for roughly 75% of global GHG emissions. Nearly all of this comes from combustion of fossil fuels. By contrast, renewable sources – once manufactured and in place – can generate electricity with no additional GHG emissions. Over 140 countries – including the largest GHG emitters – have made carbon reduction pledges. With so many countries, firms and investors across the globe focused on reducing carbon emissions, it has become a critical and material factor for all energy investors.

As the energy transition continues, fossil fuels will be increasingly displaced by renewables as a source of electricity. However, it is important to acknowledge that no single approach to the energy transition will work for all countries at every stage of their development.

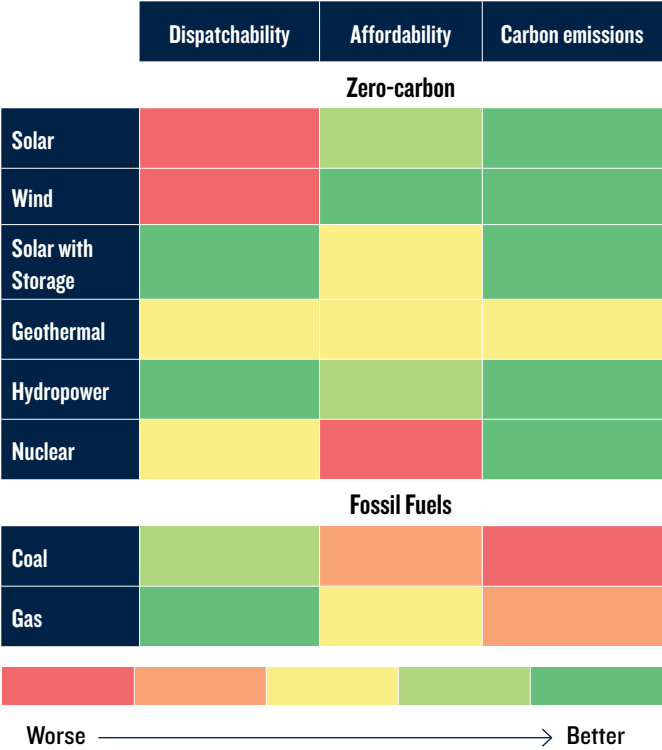
The current energy transition has been ongoing for two decades

Increase in primary sources' share of global energy consumption



Source: Energy Institute, Statistical Review 2023. March 2024.

All sources of electricity offer different tradeoffs



Note: Affordability is measured by the levelized cost of energy and carbon-emissions captures emissions per BTU.
Source: PGIM Thematic Research, Lazard, International Energy Agency and US Energy Information Administration. March 2024.



Investment Implications

The energy transition is a long, complex process with multiple tradeoffs and challenges along the way. It is important to realize there is no silver bullet and multiple energy sources will be needed to meet growing global demand. It is also important for investors to recognize the different stages of the transition to find the best opportunities, which we believe are encompassed by three overarching themes.

1. Enabling renewable energy by supporting critical inputs and complementary infrastructure

Renewable power generation has grown significantly and has reached scale in many markets around the world. However, this expansion has not been matched in other areas of renewable infrastructure – like power storage and transmission.

Enabling renewables and balancing out their infrastructure

1. Renewable debt opportunities beyond wind and solar power generation	<ul style="list-style-type: none">• Debt financing tends to be less plentiful than equity in Europe and the US. This may offer attractive investment opportunities – especially senior debt in mature projects with offtake agreements and grid connections in place.• Investors should consider looking beyond wind and solar power generation projects in Europe and the US and consider hydro and geothermal projects where they are possible.
2. India's renewable power generators offer intriguing opportunity	<ul style="list-style-type: none">• India's incredible demand growth provides a strong macro tailwind for renewable power generation companies.• Companies with an established track record of executing on projects and cash flow from existing production may be especially attractive.
3. Wind turbines offer a different risk-reward proposition	<ul style="list-style-type: none">• Wind turbines offer a way to invest in renewables with limited exposure to individual power projects and the price volatility of electricity.• Technology leaders in Europe and North America can be particularly attractive.
4. Banking on grid modernization and expansion	<ul style="list-style-type: none">• Manufacturers of key grid components – including inverters and substations – offer exposure to a rapidly growing segment of the market.• In South America, transmission companies offer exposure to a portfolio of transmission lines with cost pass-thru capabilities and attractive debt structures.
5. The need for long duration storage	<ul style="list-style-type: none">• Utility-scale power storage can mitigate the issues of intermittency and is a vital part of the energy transition.• Pumped-storage hydropower is attractive given its scale, technological maturity and dispatch capacity. While new projects are very limited, investors should consider global players with room to expand their capacity.
6. Vertically integrated energy providers	<ul style="list-style-type: none">• Given their long track record of building and maintaining infrastructure and their ability to pass-thru higher costs, regional utilities with power generation and distribution capabilities offer an intriguing investment area.• Some large energy providers finance segments of their power generating assets in private credit markets. Debt investors can find opportunities to get exposure to portfolios of mature projects.

2. Leaning into lower-carbon fossil fuels while avoiding obsolescence risk

While many aspects of the energy transition remain unsettled and unclear, one thing is certain – it will take decades, and fossil fuels are not likely to be displaced altogether. For investors, this segment of the energy complex offers opportunities to invest in elements that are quite stable, meet near-term demand, generate durable cash flows and can bridge the transition to a low-carbon world.

Meeting current demand with fossil fuels while reducing carbon emissions

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| 1. Natural gas is displacing higher carbon-emitting fuels | <ul style="list-style-type: none">• Natural gas can play a critical role in the energy transition by displacing thermal coal.• In the US, small gas producers and large LNG players offer growth potential as global demand soars.• The debt of regional pipeline operators offer investors a different risk-reward proposition. |
| 2. Debt opportunities in the mid-market | <ul style="list-style-type: none">• As banks have receded, debt financing for energy producers in the middle-market has become scarcer – creating private credit opportunities.• Investors should look for projects that have passed the exploratory phase as they offer reliable cash flows and tangible collateral. |
| 3. Big Oil and the future role of incumbents | <ul style="list-style-type: none">• Though fossil fuels will have an extended sunset, investors need to periodically consider the obsolescence risk in their exposure to Big Oil companies.• Big Oil firms that lean into lower-carbon and renewable sources may face less obsolescence risk – though these firms have not seen higher valuations from markets.• Global oil incumbents are also major players in research around green tech and clean energy. They are among the leaders in patents in areas like biofuels and carbon capture. Some may be winners in the new energy landscape. |

3. Avoiding the hype: Monitoring innovation around renewable energy sources and green tech

Some speculative innovations – like hydrogen and nuclear fusion – can garner considerable media attention, and startup firms can be characterized as plucky upstarts challenging large energy incumbents. For investors, the risk-reward propositions many of these early-stage innovations offer may not be attractive. They all have two things in common: first, they each have the potential – when fully mature and operationalized – to profoundly alter the energy landscape. Second, they each face immense challenges before they can be applied in the real world at scale.

- **Hydrogen** faces numerous challenges in transport and storage before it can be used widely.
- **Nuclear fusion** requires such extreme conditions – over 100 million degrees Celsius – that creating these conditions safely and efficiently outside of a laboratory is simply not feasible today.
- **Small modular nuclear reactors** are plagued by delays and cost overruns in new construction that renders many projects uneconomical.
- **Grid-level power storage** faces challenges around energy density, cost and efficiency.
- **Carbon capture and storage** requires significant investment in infrastructure to move vast amounts of carbon from where it is generated to where it can be sequestered. And it is unclear how to monetize such operations in the long term.





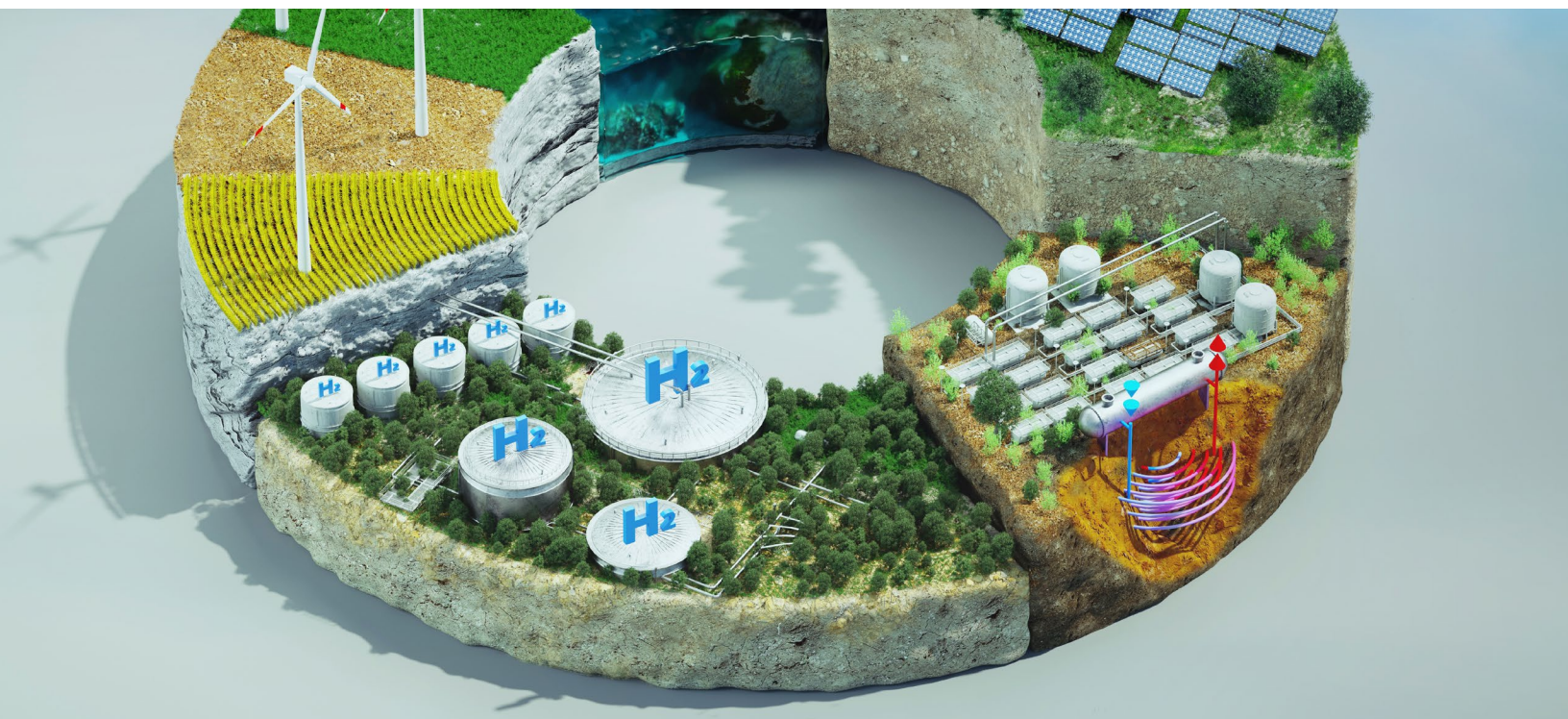
Portfolio Implications

Government action as well as ESG objectives present tradeoffs for investors that impact a range of investment decisions. Here we highlight a few of the cross-portfolio implications arising from the shifting dynamics across the global energy system and provide an action plan for CIOs.

Portfolio-wide implications

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| 1. Establish clear positions on decarbonization, investment objectives and time horizon | <ul style="list-style-type: none">• For CIOs it is imperative to clarify their decarbonization objectives with key stakeholders and align their investment timeframe with the energy transition.• Definitive answers to a few simple questions can be clarifying. |
| 2. Investors need to consider multiple approaches to decarbonization | <ul style="list-style-type: none">• Minimizing a portfolio's current carbon footprint offers the benefit of supporting current companies with low-carbon emission today, but requires evaluation of future emissions as well.• Investors that take a longer-term perspective, should consider firms that have the potential to reduce their own emissions as well as technologies with high potential to avoid carbon emissions in the future. |
| 3. Closely monitor the current landscape and future trajectory of government policy | <ul style="list-style-type: none">• Investors need to be aware of the shifting policy landscape because it alters the outlook for investment in every region.• Government policy can impact the risk-reward proposition of energy investments at every stage of development – from basic research all the way on through to large-scale projects. |

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