Energy Pragmatism: An Evolving Approach for the Mid-21st Century

September 30, 2024

BlackRock

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Key takeaways

- **In both the public and the private sectors, we see a growing focus on 'energy pragmatism,' driven by four deeply interconnected factors: national security, reliability, affordability and decarbonization.** How countries balance these four factors will differ, depending – like the energy landscape itself – on local politics, economic conditions, natural-resources endowments, technology and societal preferences.
- **This shifting focus reflects a fast-changing world.** Energy pragmatism is a practical response to rising demand, new technologies, the fraying of globalization, a more challenging economic environment, policy changes, evolving social preferences and a growing focus on decarbonization. Russia's invasion of Ukraine in early 2022 and the resulting energy crisis highlighted many of these concerns.
- **We expect investment in the global energy system to double, with a shift in its focus toward lower-carbon investments.** BlackRock projects annual energy investment will average $4 trillion per year over the next three decades – up from $2 trillion in recent years. Investment is going into both high-carbon and low-carbon sectors. The split was roughly 50/50 until 2020, but we anticipate that the investment mix will shift to 80/20 low-carbon/high-carbon by mid-century.
- **Capital markets will be instrumental in financing this investment**. With public debt at historic highs, capital from institutions and individuals will be key, along with public-private partnerships.
- **Policy will influence investment**. Clear regulations and consistent policies are key to attracting private capital for energy projects, especially with countries moving at different speeds towards decarbonization.

We need three things from our energy system. We need it to be available every minute of every day. We need it to be relatively cost-effective – otherwise it becomes a tax on the people who can least afford it. And we need it to be cleaner. All this means that there isn't a single solution. It takes a village of solutions.

Mark Florian
Head of BlackRock Global Infrastructure Funds

BlackRock's view on energy pragmatism

We first wrote about energy pragmatism in our 2024 Chairman's Letter. In this, we discussed the ways that the world is addressing energy security and decarbonization, and we stressed that our job is to help clients navigate the major shifts taking place in energy markets and the global economy. As a fiduciary, we help our clients meet their investment goals by providing multiple avenues to invest in energy and infrastructure. On our clients' behalf, we invest across strategies and asset classes, in public equity and debt markets, through both active and index strategies, as well as in private markets. Our clients choose their own investment objectives, including mandates to invest in oil and gas or lower-carbon sources of energy, or both, or neither. It's our clients' choice.

The era of energy pragmatism

The global energy landscape has changed dramatically in just a few years. Russia's invasion of Ukraine in 2022 and the resulting energy-market dislocation accelerated the ongoing adoption of what we call 'energy pragmatism': an approach to balancing the goals of energy security, reliability, affordability and decarbonization. While the political, economic and social backdrop is changing, global energy demand is expected to continue to grow. To meet this need, the world will need a variety of energy sources and technologies, including both lower-carbon and higher-carbon, for several decades to come. **Four interconnected factors are driving this shift toward energy pragmatism.**

National security

The fraying of globalization has refocused many countries' attention on energy security as part of their national-security calculus. In many jurisdictions, government policy has evolved rapidly to supplant dependence on imported energy with the domestic production of cleaner energy. Russia's invasion of Ukraine has accelerated this transformation in Europe, while economic competition among the US, Europe and China has highlighted some of the security concerns around the supply chains supporting the development, production and deployment of low-carbon technologies.

Reliability

Globally, primary energy demand has risen by more than 50% since 2000.[1] We expect demand for power in particular to continue to rise, driven in part by new technologies such as artificial intelligence, along with economic growth and industrialization, notably in emerging markets. As the appetite for power increases, the reliability of the power grid is under strain, and extreme weather has underscored its vulnerability. The growth in renewable sources of energy supports decarbonization goals but also raises reliability concerns, with the variability of solar and wind power making dispatchable and baseload power generation increasingly important.

Affordability

Inflation and an era of higher interest rates have deepened concerns about both energy affordability and economic competitiveness. Market dislocations in the wake of the invasion of Ukraine underscored the potential political fall-out of higher energy prices. At the same time, rising demand for energy and the challenges of bringing new sources into the system quickly are likely, in our view, to increase cost pressures on consumers. And the pace of the transition to lower-carbon fuels will be an important component of affordability in some countries.

Decarbonization

Multiple drivers are accelerating the transition to a low-carbon economy, including government policies, technological innovation and consumer and investor preferences. Nearly 200 countries around the world have signed the Paris Agreement, committed to decarbonization targets and are enacting policies to further these targets. A focus on energy as a national-security issue is supporting the installation of lower-carbon sources at a local level. Companies and investors are funding technological innovation that is bringing down costs and broadening scale. And social preferences are shifting as more people experience the physical impacts of climate change.

Note: Unless otherwise noted, all historical data in this paper is drawn from the Energy Institute's 2024 Statistical Review of World Energy.

Against this backdrop, the energy mix – the balance of energy inputs – becomes central to energy pragmatism. Renewables are the fastest-growing segment of the global energy market today, with solar and wind power accounting for around 60% of primary energy growth since 2015 and more than 70% since 2019. Yet this rapid growth is off a low base, and hydrocarbons continue to account for the vast majority of global primary energy consumption: in 2023, oil and coal made up 58% of the global total, and natural gas another 23%.

In other words, while renewables have helped to meet overall energy demand growth, they have not yet cut into the existing demand for hydrocarbons at the global level. And the variability of renewables – the fact that the sun doesn't always shine and the wind doesn't always blow – means that, in the absence of widespread energy storage and efficient grid connections, renewables have not yet, in many places, supplanted fossil fuels and nuclear power as the source of baseload power (the constant, minimum level of power required).

To keep up with growing demand, the world needs not only more supply but also significant investments in energy infrastructure, including expanded and more resilient electricity grids, battery and other forms of storage, smart metering, pipelines, storage and shipping infrastructure for natural gas and charging stations to support electric vehicles.

To meet these challenges, investment in the global energy system will likely double over the next three decades. Our BlackRock Investment Institute (BII) anticipates it could average $4 trillion annually – up from $2 trillion in recent years. Investment is going into both high-carbon and low-carbon sectors. The split was roughly 50/50 until 2020, but our BII Transition Scenario anticipates this will shift to 80/20 low-carbon/high-carbon by mid-century. Given the long lifetime of energy-system infrastructure, however, the increase in low-carbon capital expenditures will precede changes in the energy mix. As a result, we expect that hydrocarbons will still make up roughly half of the global primary energy mix by mid-century.

It is likely to be an all-of-the-above solution for quite a long time. The world will get a lot more renewables, and more energy storage, but the world will still need investment into the hydrocarbon mix, particularly natural gas, which is the least carbon-intensive form of traditional energy.

Alastair Bishop
Portfolio Manager, BlackRock Fundamental Equities

The BII Transition Scenario

For a deep dive into our investment research on the low-carbon transition, see the BlackRock Investment Institute (BII) hub.

BII leverages BlackRock's expertise and generates proprietary research to provide insights on macroeconomics, sustainable investing, geopolitics and portfolio construction to help Blackrock's portfolio managers and clients navigate financial markets. BII sees the transition to a low-carbon economy as among a handful of major structural shifts that are rewiring economies, sectors and businesses.

The BlackRock Investment Institute Transition Scenario (BIITS), powered by Aladdin® technology, is a research-based, analytical forecast of how the low-carbon transition could unfold. BIITS attempts to model what is most likely to occur – rather than what anybody thinks should happen or a specific outcome. It is based on rigorous research and the input of BlackRock's portfolio managers and other experts.

BIITS sees a multi-speed transition with both investment risk and opportunity, as sectors and regions move at different speeds, driven by shifting technology and societal preferences, and as policymakers balance different objectives.

Like all forecasts, BIITS comes with considerable uncertainty, which requires tracking and updating over time. We are actively updating our work and the capital-market assumptions that utilize it. As with all our research, it is each client's choice to use or not and agree or not — views on energy and markets differ.

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Setting the scene: growth in global energy demand

Setting the scene: growth in global energy demand

As energy demand continues to grow, the challenge for the world will be to produce enough supply while balancing the needs of security, reliability, affordability and decarbonization.

Globally, primary energy consumption rose by roughly 56% between 2000 and 2023, though the rate of growth has slowed slightly in recent years. While consumption remained essentially flat in OECD economies overall and in the US, it declined by 13% in the EU and by more than 20% in Japan. In developed economies, the flat total growth story is actually two stories: strong growth in renewables and natural gas on the one hand, with declines in coal and oil on the other. This trend has accelerated since 2015, with a 9% annual growth rate making renewables the primary source of energy growth.

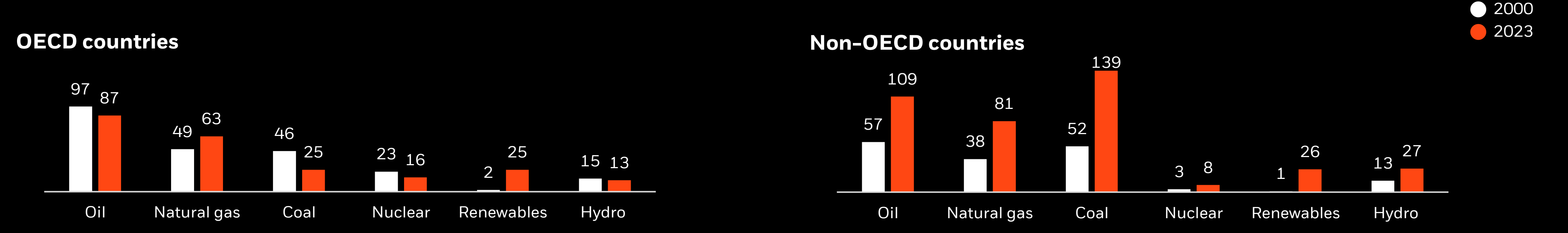
Outside the OECD, primary consumption is more than twice as high now as in 2000 – three times as high in India and four times in China – thanks to faster economic and population growth. China has rolled out renewables rapidly in recent years, accounting for 60% of the world's solar and wind installation in 2023,[2] but abundant and inexpensive coal has driven much of the recent increase in consumption in both China and India.

Looking ahead, we expect that global energy demand will continue to increase, most notably in emerging markets, but the composition of this demand will look different to the past. Although aging populations will weigh on economic growth and energy consumption in many developed economies and in China, the story is quite different in many emerging economies, where higher output, growing populations and ongoing industrialization are likely to push demand higher. Across developed and emerging economies alike, the world is likely to be richer, with greater wealth boosting demand for energy-intensive goods and services like consumer products, air conditioning, protein-rich food and travel.

Technology will affect energy demand – in both directions. At the macroeconomic level, technology can improve energy efficiency and reduce the energy-intensity of economic output. But new technologies can also drive higher demand – as we are already seeing with the anticipated growth in artificial intelligence (AI) and the rapid build-out of supporting data centers.

A changing global energy mix since the start of the century
Primary energy consumption by fuel type (exajoules)

Source: Energy Institute, *2024 Statistical Review of World Energy*
OECD: Organization for Economic Co-operation and Development



Artificial intelligence: a new driver of energy demand

Artificial intelligence (AI) is highly power-intensive: the average search with first-generation generative AI used nearly 10 times as much energy as a conventional web search.[3] While estimating the growth of AI and its related energy demand is difficult, today's estimates are large. The International Energy Agency (IEA) estimates that data centers could require around 670 TWh by 2026, up from about 350 TWh in 2022, with AI demand reaching roughly 100 TWh from a negligible level. A BlackRock review of estimates from energy and sell-side research firms suggests a range of 400-1200 TWh of incremental power demand by 2030, from 2023 levels, with a median of 700 TWh.

For context, this would represent about 2.5% of current global electricity consumption and 13% of total projected global power demand growth to 2030 under the IEA's stated policies scenario — which would be on par with the growing power needs of the entire transportation sector.[4]

The trend is expected to be much more significant in the US, where overall electricity demand growth has been essentially flat for 15 years and where AI data centers are expected to be concentrated.

In the US, data centers could grow from about 4%-5% of power demand today to 6%-10% or even higher under some bullish AI capex projections. Even two percentage points would represent a massive increase in the capital needed to allow electricity power providers to ramp up at a pace not seen for decades. Given the geographic clustering of data centers in areas where renewable power may be constrained, and the fact that wind and solar are intermittent power sources, it may be difficult for renewables alone to meet this demand.

Accordingly, meeting this AI-driven demand may also require natural gas and nuclear power, which in turn will likely require more gas pipelines, gas-fired power plants, transmission lines and modern smart grids.

Regardless of the energy source, transmission will remain a challenge, requiring more investment and changes to regulatory approval processes.

Some supply may need to come from behind-the-meter or local power technologies sited adjacent to new data centers. Over time, power generation could come from small nuclear reactors, geothermal energy and even, perhaps, fusion technology. While these technologies might be more expensive than renewables, they might still be needed to meet fast-growing demand, and they may be affordable for the tech hyperscalers that are behind this demand.

Yet, on a longer horizon, AI may partially – or even fully – offset increased power demand by driving optimization and efficiency across energy and power systems and end-uses like buildings, industry and transport.

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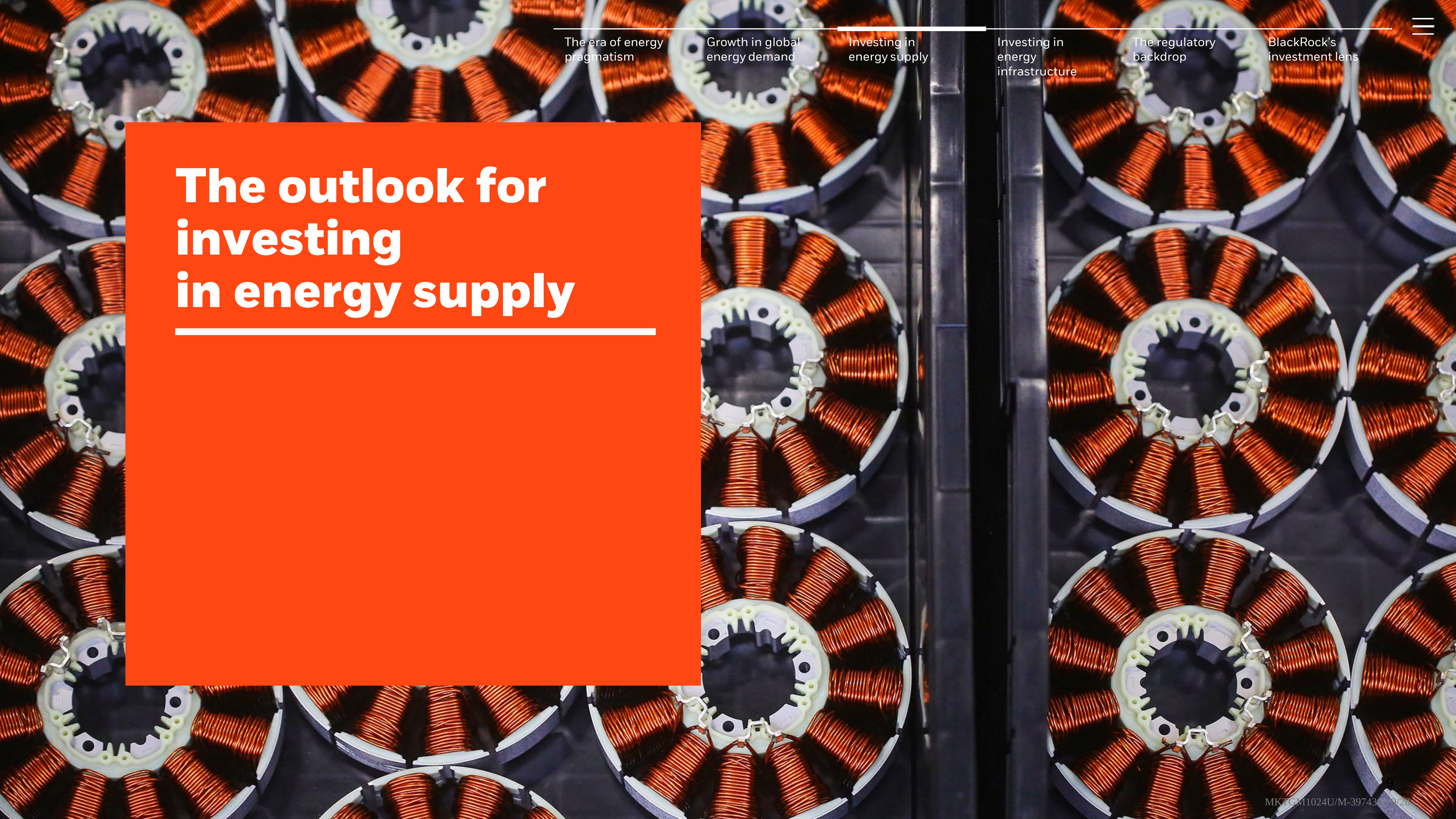


The outlook for investing in energy supply

The outlook for investing in energy supply

Even with the growth in renewable energy over the past decade, coal, oil and natural gas still account for roughly 80% of the world's primary energy demand. The balance comes from renewable solar and wind, hydropower, nuclear and bioenergy. While renewables have helped to meet overall energy demand growth, they have not yet cut into the existing global demand for hydrocarbons.

Projecting the future energy mix is difficult and risky, given the high degree of uncertainty in the macroeconomic outlook and in the fundamental drivers of the energy transition – technology, policy and consumer and investor preferences. All of these can change quickly, with the rapid emergence of AI just one illustration of this.

While estimates vary, the widely cited Stated Policies Scenario[5] from the International Energy Agency (IEA) points to an increase in renewables' share of world energy consumption from 12% in 2022 to 31% by 2050. Under this scenario, the share of nuclear energy is also expected to grow, while the shares of natural gas, oil and, most dramatically, coal are projected to decline.

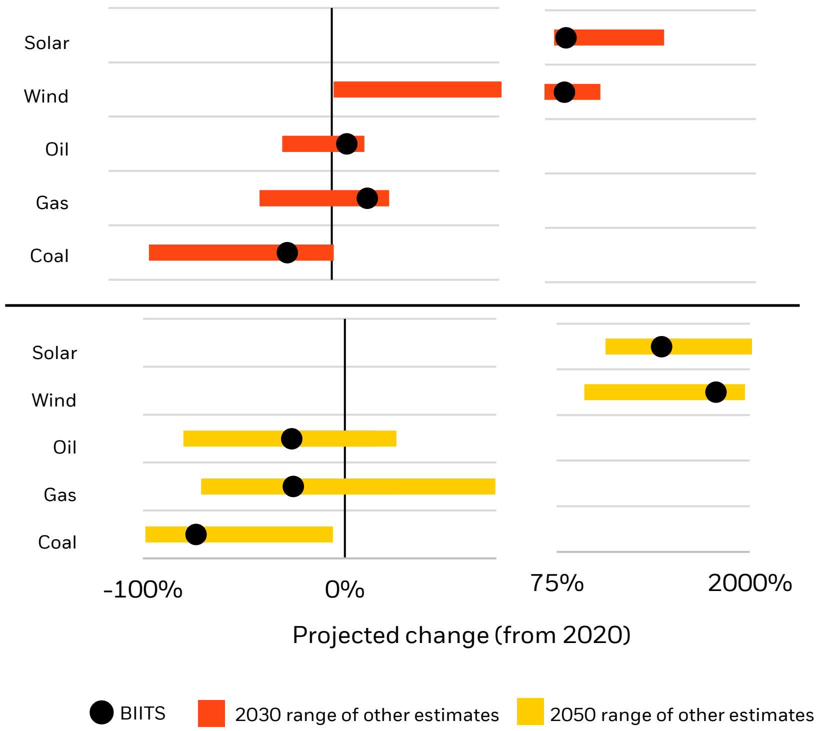
Taking a wider lens, the chart alongside draws on our BII Transition Scenario[6] (which we discuss in the box on page 5) to illustrate the wide range of estimates of changes in demand for different energy sources.

While all scenarios point to renewables growing to many multiples of their recent levels, the extent of the decline in hydrocarbons is highly scenario-driven and timeframe-dependent.

We anticipate that renewables and lower-carbon technologies will play an increasingly important role in meeting demand growth and eventually in displacing traditional energy in the mix. At the same time, we think it is likely that traditional sources (some coupled with carbon capture) will still account for roughly half the global energy mix by mid-century.

As we discuss in more detail in our BII Transition Scenario, our expectation is that the transition from high-carbon to lower-carbon energy systems will play out over decades – and at different speeds in different countries and sectors, reflecting policy choices, consumer preferences, technological innovation and natural-resource endowments.

Estimated changes in global energy sources by 2030 and 2050



Sources: BlackRock Investment Institute and Aladdin Sustainability Analytics, July 2023. Notes: To produce BlackRock Investment Institute Transition Scenario (BIITS) insights, we turn our views and research into quantitative inputs for our scenarios modeling to create the BIITS insights. BlackRock's Aladdin® platform is a financial technology platform designed for institutional use only and is not intended for end investor use. Secondary research and third-party sources used include energy data, scenario data, market intelligence and energy research providers. For illustrative purposes only. Subject to change without notice.

Note: The IEA's Stated Policies Scenario reflects current policy settings based on policies in place, as well as those under development, as of August 2023. The scenario takes into account currently planned manufacturing for clean energy technologies. In addition, the IEA has modeled two other scenarios: one that represents the achievement of climate pledges, and another that achieves net-zero emissions by 2050.
Note: The chart, drawn from our BII Transition Scenario, shows the large uncertainty in demand across different scenarios (bars) for different parts of the energy mix, with uncertainty ranges growing with time. BII's investor-informed view sees near-term growth for most forms of energy with much faster growth for low-carbon sources. We also see more uncertain but eventual and gradual decline in demand for traditional energy sources, as low-carbon sources eventually begin to substitute amidst still-resilient demand in emerging markets and harder-to-decarbonize sectors.

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Energy pragmatism and climate change

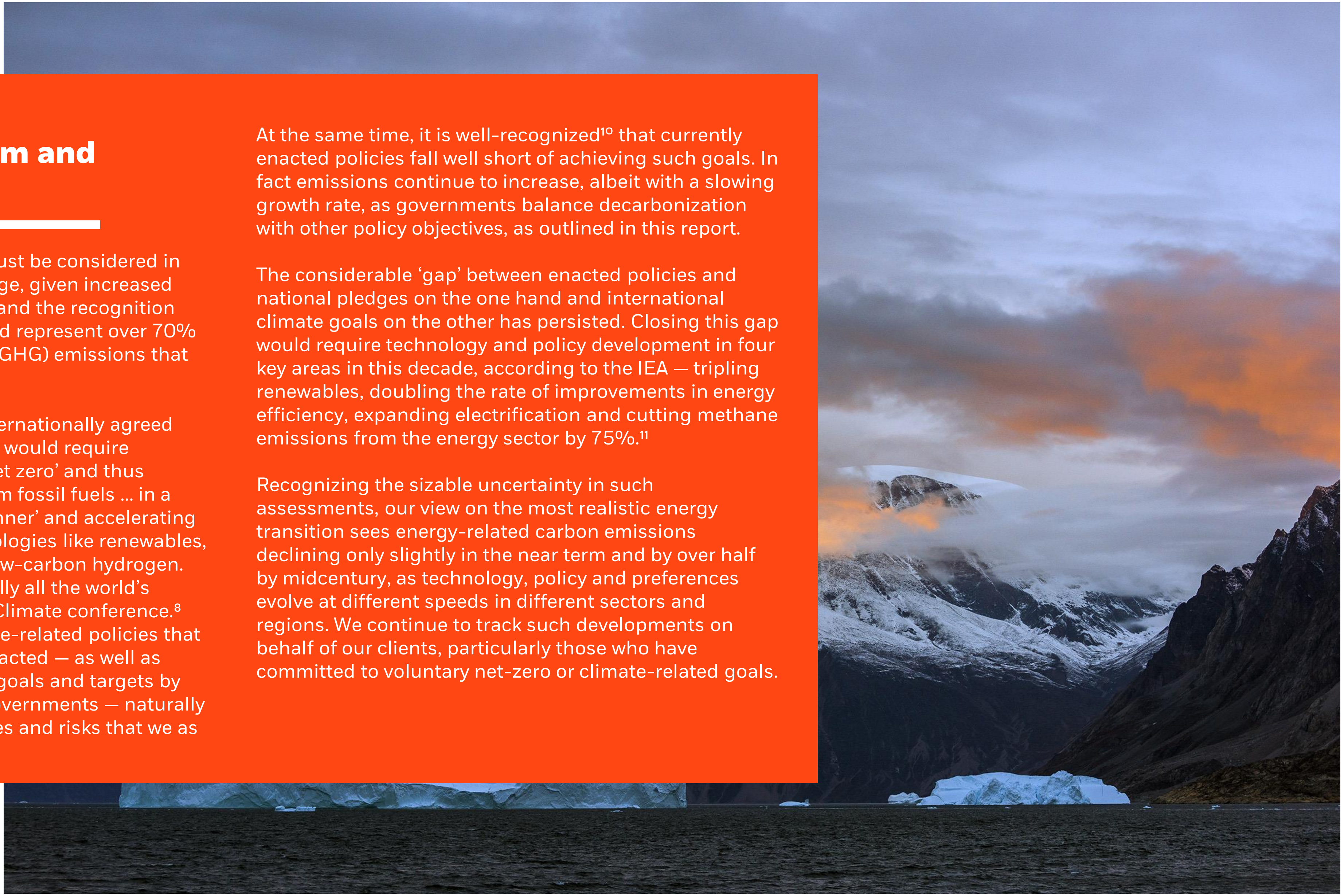
Energy policy and investing must be considered in conjunction with climate change, given increased societal attention to the issue and the recognition that energy supply and demand represent over 70% of the global greenhouse gas (GHG) emissions that drive it.[7]

Limiting climate change to internationally agreed targets in the Paris Agreement would require reducing GHG emissions to ‘net zero’ and thus require ‘transitioning away from fossil fuels … in a just, orderly and equitable manner’ and accelerating zero- and low-emission technologies like renewables, nuclear, carbon capture and low-carbon hydrogen. This has been agreed by virtually all the world’s governments at the 2023 UN Climate conference.[8] Thus, the thousands[9] of climate-related policies that national governments have enacted — as well as supportive voluntary net-zero goals and targets by corporates and subnational governments — naturally create investment opportunities and risks that we as fiduciaries track.

At the same time, it is well-recognized[10] that currently enacted policies fall well short of achieving such goals. In fact emissions continue to increase, albeit with a slowing growth rate, as governments balance decarbonization with other policy objectives, as outlined in this report.

The considerable ‘gap’ between enacted policies and national pledges on the one hand and international climate goals on the other has persisted. Closing this gap would require technology and policy development in four key areas in this decade, according to the IEA — tripling renewables, doubling the rate of improvements in energy efficiency, expanding electrification and cutting methane emissions from the energy sector by 75%.[11]

Recognizing the sizable uncertainty in such assessments, our view on the most realistic energy transition sees energy-related carbon emissions declining only slightly in the near term and by over half by midcentury, as technology, policy and preferences evolve at different speeds in different sectors and regions. We continue to track such developments on behalf of our clients, particularly those who have committed to voluntary net-zero or climate-related goals.



Solar and wind

Investments in solar and wind technologies continue to accelerate, with solar now accounting for 6% of global power generation and wind 8%.[12] Sharp price declines since 2010 have made these technologies increasingly cost-competitive, and solar and onshore wind now represent the lowest cost of bulk power generation in many places, helped by supportive regulatory regimes. Offshore wind installations have slowed in the face of supply-chain challenges and higher borrowing costs, but we still see significant opportunities in onshore wind, not least because it often complements solar by generating power during off-peak and nighttime hours. BII anticipates that solar and wind, along with batteries, will remain critical decarbonization technologies around the world.

Wind and solar power installations reached a record in 2023. In the US, solar made up more than half of the new power capacity additions, and solar and wind together are set to comprise over 70% of new additions in 2024. China installed as much solar capacity as the rest of the world in 2023, while its wind installations grew by two-thirds; we expect China to install more than half of new capacity globally over the next four years. In the EU, the geopolitically driven need to reduce reliance on imported natural gas spurred the installation of more than 55GW of wind and solar power in 2022 – a record – growing to 66GW in 2023.

Texas case study

Texas – which has a long history as a center of the global oil market – is now a leader in renewable energy in the US. Renewables accounted for nearly 40% of the state's total installed generation in 2022, up from 21% in 2017.[13] In 2023, the state led the country in new solar capacity and generated nearly three times as much wind energy as the next state.[14]

With both its economy and population growing faster than the national average, energy demand in the state has grown rapidly. Coupled with the fact that it has an independent energy grid not linked to the rest of the country's, this means that Texas has an urgent need for more dispatchable power that can be generated on demand.

Renewables are inherently intermittent, which can bring increased volatility into the power grid.

In Texas, when variability in the actual generation of renewables coincides with a demand peak, the energy shortfall causes prices to spike. The Texas grid tries to manage this problem of renewables intermittency with new gas-fired power and battery storage. In times when this is not sufficient to balance the system, the state may face curtailments of some large consumers or, in extreme cases, rolling blackouts.

The state government has worked to attract investment into dispatchable generation, passing two bills in 2023 to provide up to $10bn to support transmission, distribution and generation facilities and to introduce reliability requirements for future generation facilities and compensation mechanisms for dispatchable generation. The state is also considering significantly expanding the deployment of small modular nuclear reactors if they meet reliability and safety concerns.

Onshore wind continues to be interesting, especially in the US. Some of the best wind sites in the world still have early-2000 vintage turbines operating on them. At the same time, they've been collecting data, and manufacturers in this space have gotten smarter and developed a kit that can utilize existing tower infrastructure. I think there is an underappreciated opportunity onshore, for both new build and repowering.

David Giordano
Global Head of BlackRock Climate Infrastructure

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Nuclear power

Carbon-free but politically sensitive nuclear power accounts for 4% of global primary energy consumption and a much higher share in several countries, including France and South Korea. Despite its benefits in terms of reliability and decarbonization, nuclear power has been politically controversial in many countries and grew only more so after Japan's Fukushima incident in 2011. This is beginning to change, however, in part due to geopolitics. Large nuclear projects have been marked by delays, cost over-runs and safety concerns. But it may be possible to build small modular reactors (SMRs) more cheaply and quickly than larger projects, and the storage and disposal of waste could pose a smaller risk. As the technology develops, small reactors can support a decentralized electricity grid and could be particularly important in powering industrial applications or data centers outside densely populated areas.

I believe small modular reactors (SMRs) are the future of nuclear power. Large, complicated central plants have materially higher costs, plus insurance, decommissioning and waste issues. SMRs deal with almost all of that. The scale means that safety is far less of a concern and the waste is much smaller and easier to dispose of. You can build SMRs in a factory and get more economies of scale – although production at that scale is more than five years away.

David Giordano
Head of Global BlackRock Climate Infrastructure

Japan case study

Given Japan's highly limited natural resources, energy security has been an important political goal for decades. Today, following the shutdown of the country's nuclear program after Fukushima, oil, natural gas and coal account for more than 80% of the country's primary fuel mix. The government now plans to increase nuclear power, currently about 8% of electricity generation, to 20%-22% by 2030. Alongside ambitious targets to reduce greenhouse gas emissions by 45% from 2013 levels by 2030 and to achieve net zero by 2050, the government is providing significant funding for nuclear and hydrogen.

The government's 2023 Green Transformation policy establishes a roadmap for Yen150trn in public-private financing over the next decade, with the goal of transforming 22 industrial sectors, including renewables, green building, electricity networks and electric vehicles. The roadmap also supports the restart, new build and lifetime extension of nuclear power plants. The government has begun the issuance of a planned Yen20trn in transition bonds for both traditional low-carbon initiatives and innovative technologies.

Energy efficiency is an important component of the strategy, with the government encouraging improved efficiency through subsidies, fiscal incentives and voluntary industrial commitments. The energy-intensity of GDP has already fallen by nearly one-third between 2000 and 2020.

Fusion

Fusion technology could potentially offer near-limitless power without producing greenhouse gases or radioactive waste. But commercializing this technology is in the early stages of development and will require substantial public investment in research. Most BlackRock investors consider commercial fusion to be at least a decade away – but the technology could ultimately represent a sizeable shift in the energy transition.

Hydrogen

Hydrogen is a chemical feedstock, or fuel, that can be produced in a low-carbon manner, from natural gas, renewables, nuclear or biomass, and burned without producing carbon emissions. It is energy-dense and can be used in industrial processes and potentially transportation. Further investments in hydrogen as a fuel may be driven by major oil and gas producers, who see it as a new application for their natural gas.

Hydropower

Hydroelectric power is a major source of primary energy consumption in many countries in Europe (nearly two-thirds of all energy consumption in Norway), South and Central America and in New Zealand, although in relative terms less so in China or the US. Geography obviously limits the sites where hydropower can be important, and climate change itself (in the form of melting glaciers and droughts) undercuts the viability of some projects. Hydropower also often faces criticism on environmental and social grounds. Overall, we do not see significant growth prospects at a global scale, relative to other technologies.

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Bioenergy

While traditional forms of bioenergy such as wood, charcoal and animal waste are still in use, the focus of innovation is in 'modern biofuels.' These are produced from organic inputs and can be transformed into liquid fuels, which are used mainly for transportation. Progress on making this technology commercially competitive has been slower than some had expected, and it is worth noting that many inputs are land-intensive and compete with other land uses, including food and forestry.

Enhanced geothermal

Enhanced geothermal energy is 'the next frontier for renewable energy deployment,' according to the US Department of Energy.[15] This carbon-free source can provide renewable energy around the clock, without the intermittency problems of solar and wind. Enhancing naturally occurring geothermal systems makes existing sources of heat more accessible and therefore makes geothermal energy potentially more widely available. BlackRock investors think we may see limited early adoption by the early 2030s. In Iceland, traditional geothermal already accounts for nearly 70% of total energy use.

Germany case study

Geopolitics are reshaping Germany's energy mix, which was upended by Russia's invasion of Ukraine in early 2022. Before the invasion, Germany imported 65% of its natural gas from Russia, making it by far Russia's largest gas customer[16] and leaving it vulnerable to the impact of Western sanctions on Russian gas exports.

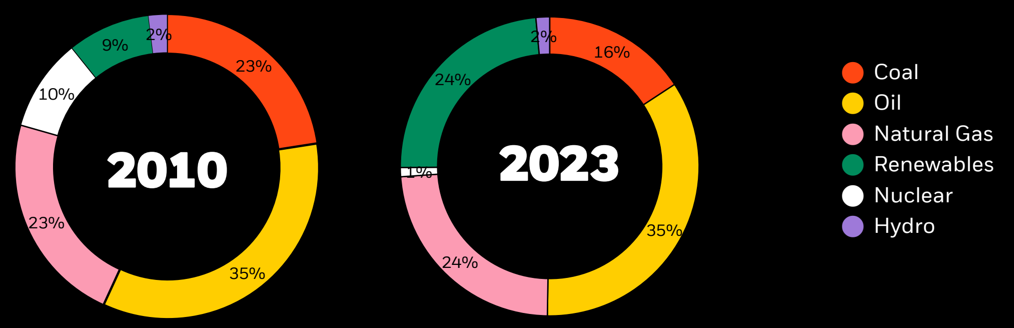
This occurred against the backdrop of Germany's push to fully decommission its nuclear plants, which had supplied about 25% of the country's electricity needs before the Fukushima incident in 2011. A long-running phase-out of all the country's nuclear reactors was completed in spring 2023, having been delayed just a few months in response to the invasion.

Germany has turned to imports, with a deal for pipeline gas from Norway and liquified national gas imports from countries including the US and Qatar. A public-private partnership has driven a major and rapid rollout of floating storage and regasification units.[17]

Through the energy crisis, Germany temporarily increased its reliance on coal, but coal consumption fell to a more than 50-year low 2023. In the same year, renewables and hydropower supplied more than 50% of the country's electricity for the first time. Germany remains committed to closing all its remaining coal-fired power stations by 2038 and to replacing coal with renewables.

Germany's energy mix 2010 vs. 2023

% of total primary energy consumption



Source: Energy Institute, *2024 Statistical Review of World Energy*

Shifting to traditional fossil fuels:

Natural gas

Natural gas is significantly less carbon-intensive than coal in providing reliable power generation. (This is the case at least as long as 'leakage' rates remain low. 'Leakage' describes the gas that accidentally enters the atmosphere during production and transport.) Natural gas is an important source of power capacity and generation in many countries, serving a variety of roles as baseload power, peaking power, load following or a way to balance intermittent renewables. Depending on the local context, this flexibility can make natural gas an important driver of several elements of energy pragmatism, including reliability, affordability and, in some cases, decarbonization.

Assessing future demand for natural gas is especially challenging given the diversity of uses for it – from power generation to heating, cooking and feedstock. Power-generation demand for natural gas is flat or falling, and its use in buildings (primarily for heating and cooking) is declining in developed markets. But industrial demand has not yet shifted.

Overall, a variety of projections point to further demand growth in the near-term. Over the longer term, as renewables continue to scale up, natural gas could evolve from a source of primary power generation and become a source of 'capacity' – back-up, stand-by power that can offset the intermittency of renewables. Moreover, natural gas may have a future as an underlying input for blue hydrogen.

Oil

Oil remains the world's largest source of energy, accounting for slightly roughly one-third of primary consumption in 2023. The IEA anticipates that global demand will increase slightly to 2030. While demand for gasoline and diesel in developed markets is likely to decline due to the adoption of electric and hybrid vehicles and improved transport efficiency, this is likely to be offset over this timeframe by continuing demand growth in aviation, petrochemicals and emerging markets as a whole.

I think more than half of the incremental power demand to 2030 will need to be powered by natural gas. There simply won't be enough economically viable wind, solar and backup grid-scale batteries to support rapid global energy demand growth without reliable, dispatchable power. There is also a huge opportunity for liquified natural gas exports from the US to phase out the enormous amounts of coal being burnt in Asia.

Will Su
Head of Energy Equities

India case study

India is heavily reliant on traditional fuels, with coal accounting for more than half its primary energy mix and 75% of its power generation. In absolute terms, India consumes about 60% more coal than the US and the EU combined (although still only one-quarter of what China consumes). Renewables accounted for just 6% of primary energy and 12% of power in 2023.

The Indian government is focused on reducing reliance on imports of traditional fuels: it is streamlining regulations around exploration and production of oil, gas and coal and opening coal mining to private companies and oil and gas markets to foreign investment. The government has introduced ambitious targets for renewables, with large-scale auctions and subsidies to promote solar. Public-sector institutions are making capital investments in energy-related projects, while public finance institutions have stepped up lending to energy projects.

Coal

Coal, the most carbon-intensive fuel, drives more than one-quarter of the world's primary energy consumption today. In OECD countries, the share has fallen significantly to just 11%, but in non-OECD countries the share is 36%, and aggregate demand is still rising. The near-term outlook for coal will depend on whether the rate of decline in developed markets can outpace the rate of growth in emerging markets, particularly in Asia. Over the long term, most market observers anticipate a sharply reduced role for coal globally.

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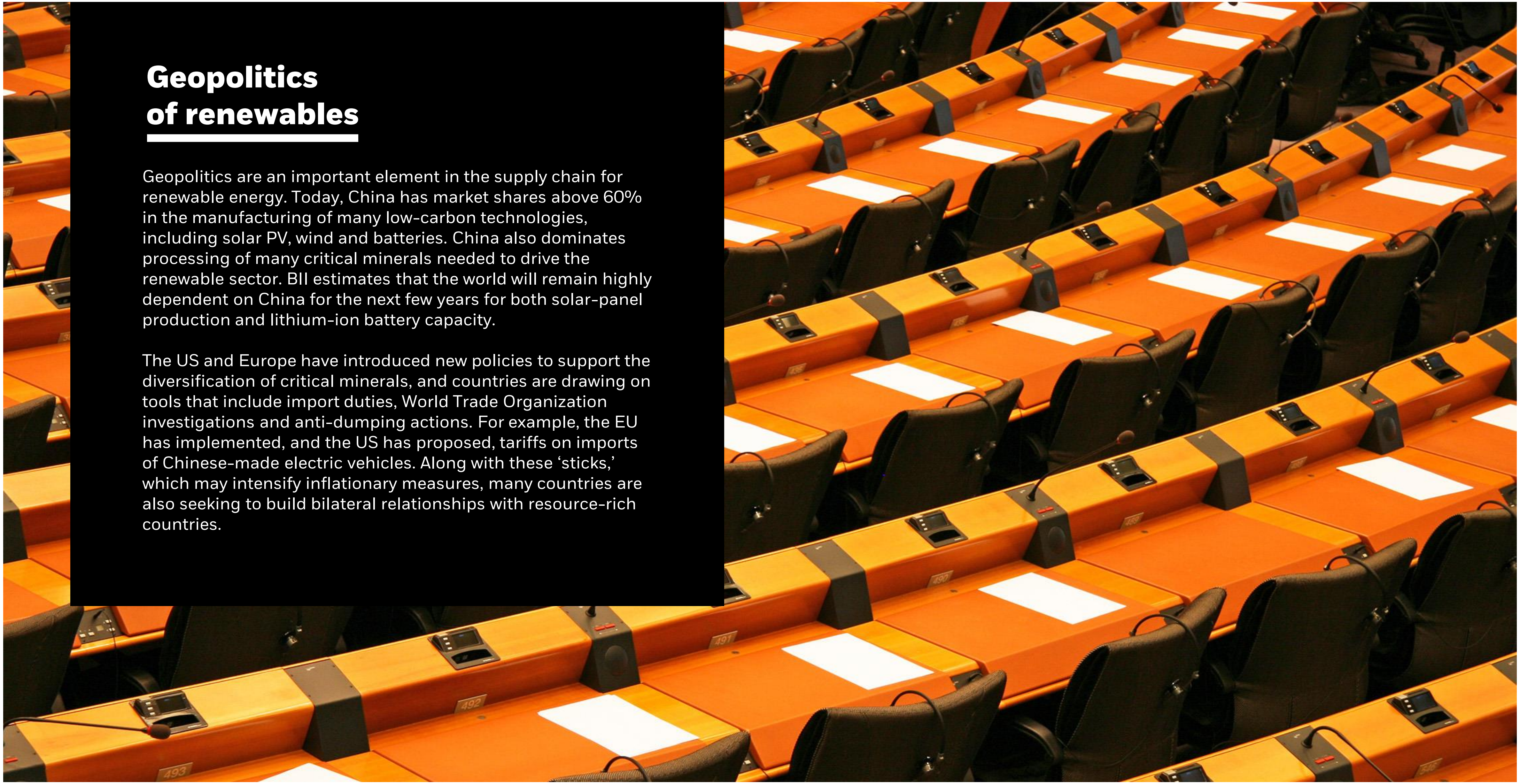

Geopolitics of renewables

Geopolitics are an important element in the supply chain for renewable energy. Today, China has market shares above 60% in the manufacturing of many low-carbon technologies, including solar PV, wind and batteries. China also dominates processing of many critical minerals needed to drive the renewable sector. BII estimates that the world will remain highly dependent on China for the next few years for both solar-panel production and lithium-ion battery capacity.

The US and Europe have introduced new policies to support the diversification of critical minerals, and countries are drawing on tools that include import duties, World Trade Organization investigations and anti-dumping actions. For example, the EU has implemented, and the US has proposed, tariffs on imports of Chinese-made electric vehicles. Along with these 'sticks,' which may intensify inflationary measures, many countries are also seeking to build bilateral relationships with resource-rich countries.

The outlook for investing in energy infrastructure

The outlook for investing in energy infrastructure

Energy-system infrastructure also provides meaningful investment opportunities.

Perhaps most vital is the need to reinforce and expand the existing grid. This is needed to address challenges of transmission bottlenecks, weak resilience, constraints on local distribution and the higher demand created by growing electrification, energy access and economic growth, as well as the projected rapid increase in data use and AI.

Challenges to the existing grid

01 Transmission bottlenecks

Transmission bottlenecks are a serious obstacle to the deployment of renewable power, which is often produced far from consumer and industrial activity and must be transmitted over long distances. This is true in many countries, including in Germany, where wind energy is available along the northern coast but energy-intensive industries are concentrated in the south and west, and in the US, where some of the top wind-power producing states are far from the densely populated coasts.

Adding smaller, more geographically distributed and intermittent power generation sources to the network increases supply but can also put pressure on the grid in terms of both the physical ability to connect and the ability to manage varying load.

02 Resilience

Resilience – or the ability of the power grid to withstand extreme weather, natural disasters and major power disruptions – is an ongoing concern as these events place unprecedented strains on outdated grids. The inability of power generators and the grid to cope with severe winter storms was an important factor in the 2021 blackout in Texas,[18] while bare power lines have contributed to numerous wildfires in California in recent years.[19]

03 EV adoption

As electric and plug-in hybrid vehicles expand in a market previously dominated by combustion engines, heat pumps replace oil and gas heating and more industrial processes become electrified, pressure on the existing grid will continue to rise. Greater adoption of EVs will require significant investments in charging stations – which may themselves be powered by electricity generated from fossil fuels – and transmission lines. The pace of mainstream adoption of EVs varies across countries, with some dependent on government incentives and some seeing renewed interest in hybrid and plug-in hybrid vehicles.

Behind-the-meter solutions

All this creates opportunities, not only for utilities to invest in expansion and resilience, but also for ‘behind-the-meter’ solutions that generate and/or store power locally. These solutions can provide an alternative to grid expansion and may be particularly valuable for stand-alone, and sometimes isolated, installations like data centers (though less so when data centers are located near urban areas). A network of behind-the-meter supply and storage that is connected to the grid can help to strengthen the grid, particularly when combined with smart-meter technology. Moreover, such projects may be able to avoid some of the regulatory and permitting constraints that can slow large-scale deployments.

Natural gas investments

Wider use of natural gas will require further investments in pipelines, storage, gas terminals and export platforms. The disruption of Russian supply of natural gas to Europe has already changed the market, boosting investments in liquified natural gas import and export facilities globally. This new wave of LNG projects is expected to start to come online in 2025, with the potential to deliver nearly twice as much natural gas as Europe had previously imported from Russia; more than half of the new capacity could come from the US and Qatar in the next few years.[20]

I’d say the biggest opportunity in the power sector is the global trend towards decentralizing the power grid. Batteries are a huge part of that, especially as a result of the increase in renewable energy sources coming online, as well as the growing number of climate-related events. Storage helps with grid resiliency by helping match energy production and consumption both temporally and locationally. There’s more demand for storage all around, to help store renewable energy for use later and even to build battery storage instead of traditional electric substations to help with load growth near population centers.

Akhil Mehta
Investor, BlackRock Global Infrastructure Funds

Digitization of the energy grid

Digitization of the energy grid offers opportunities to improve efficiency by better matching supply and demand during peak periods, as well as opportunities to improve resilience and reliability. Digitization can also reduce emissions from technical losses, akin to leakages, which the IEA estimates to be roughly twice the emissions of all cars in Europe.[21] The IEA estimates that annual investment needs here will more than double to some $750bn by 2030.[22] As we noted earlier, AI is likely to be important over time in improving reliability and matching supply and demand.

Battery storage

Building out the grid creates opportunities for the greater deployment of battery storage, which is vital to transforming renewable energy into power that is available 24/7. Stationary storage is expected to grow at a 21% CAGR to 2030, more than twice the growth rates of solar and wind, though from a lower base.

Carbon management

Carbon management projects pull carbon dioxide (CO2) from power plants and industrial processes; some store the CO2 underground or in cement while others use it to produce fuels, chemical feedstocks or building materials. An additional form, direct air capture, pulls CO2 directly from the atmosphere and stores it underground. Sequestration projects do not have direct revenue streams and so depend on government incentives and voluntary markets. Carbon management is highly capital-intensive, meaning that projects tend to be centered in large companies that can provide cash flow and technical and operational expertise. Accordingly, we see opportunities for public companies to partner with private capital that is seeking long-term, infrastructure-like returns.

Large energy companies can invest in new technologies while still being very profitable for their base investors. They are driving innovation, which you can see in the patent data. They are investing in carbon sequestration and green and blue hydrogen.

Will Su
Head of Energy Equities

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The regulatory backdrop

The regulatory backdrop

Governments have many tools to shape their energy policies: subsidies, tax incentives, decarbonization targets (to meet global commitments or national transition plans), permitting regulations, environmental and labor standards, domestic-content specifications, trade policy and more. As the case studies throughout this paper illustrate, national policy mixes designed to balance the goals of security, reliability, affordability and decarbonization will differ across countries. The mix of policies will depend – like the energy landscape itself – on local politics, economic conditions, natural-resources endowments, technology and societal preferences.

We recognize that different jurisdictions will implement different policy measures, at different paces. From our vantage point as investors across countries, markets and asset classes, we wish to flag the importance of policy clarity and consistency over time as among the most critical factors supporting the deployment of private capital. We believe this deployment of private capital – often in conjunction with public-sector funds – will be critical to drive funding to where it is most needed.

Regulatory certainty is an important driver of the risk premium for long-term investments. Because uncertainty increases an investment's risk profile, it raises the cost of providing private capital. This is particularly acute for projects with multi-year and even multi-decade horizons.

Planning, approval and permitting processes are common sticking points that illustrate the risks of regulatory uncertainty. Administrative complexity and legal challenges can delay both new projects and grid interconnections for existing renewables projects. In Europe and the US, the permitting process can take longer than the construction process, and deployment times are far higher than in China.[23] For example, in the US it can take as long as 13 years to deploy an extra-high-voltage line, compared to fewer than four in China.

These regulatory backlogs make permitting more of a binary risk, not simply a question of cost, which is likely to lead to higher risk premia. According to our investors, permitting challenges around carbon-management solutions designed to store CO2 underground have chilled investments in some areas.

In contrast, the 10-year horizon of the clean-energy tax credits in the 2022 US Inflation Reduction Act (IRA) helped to spark subsequent significant innovation and investment in new transition technologies.[24] In the UK, the new government is proposing to overhaul the national planning framework to prioritize development of renewable energy generation and related infrastructure. Greater certainty and speed could help to reduce the risk premia around such projects and address some of the concerns we hear from companies wishing to develop energy-infrastructure projects.

Public-private financing structures and blended finance will be critical to meet the scale of the investment needed in coming decades. Structures that facilitate cooperation between public and private sector investment will be able to more effectively leverage public capital, whether from national governments or multilateral institutions such as the World Bank and regional development banks. Blended-finance structures can attract global capital to projects in countries where risk-adjusted returns are not attractive enough or where the scale of the opportunity exceeds local market capacity. Getting the financing right with catalytic capital to derisk investments can help to unlock global capital flows.

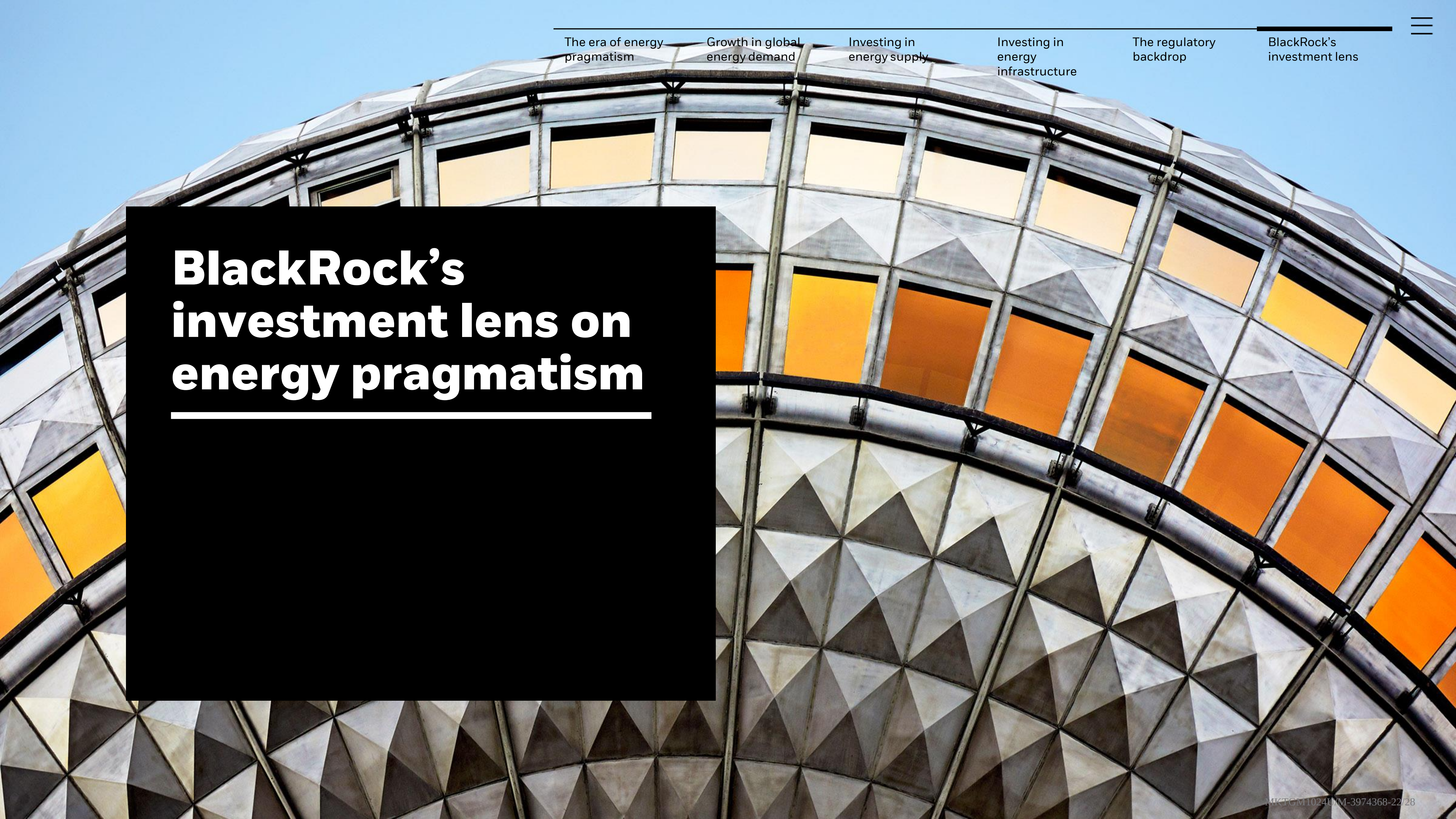
UK case study

The UK has adopted energy pragmatism by accelerating the uptake of renewables and zero-carbon energy while maintaining a role for hydrocarbons in the future.

The UK currently gets roughly one quarter of its total energy, and more than 60% of its power, from nuclear, hydroelectric and renewables. The country has been a leader in wind power, with installed wind turbine capacity increasing by an average of 10% annually between 2013 and 2023. A public-private partnership begun in 2015 has been important in derisking the development of new capacity.

Nonetheless, the country's exposure to hydrocarbons left it significantly exposed to wholesale energy prices after Russia's invasion of Ukraine in 2022, when residents faced the prospect of energy prices increasing by 80% in just a few months. Emergency steps offset some of this – but underscored the fiscal desirability of reducing hydrocarbon exposure.

As such, the government elected in July 2024 has made it a 'mission' to achieve clean energy by 2030 and plans to lean heavily on private-sector investment to achieve it. The government wants to double onshore wind, triple solar power and quadruple offshore wind by 2030 and is also focused on small nuclear reactors. However, the government's election manifesto recognizes the 'ongoing role of oil and gas in our energy mix' and wants to maintain a 'strategic reserve of gas power stations to guarantee security of supply.'



BlackRock's investment lens on energy pragmatism

BlackRock's investment lens on energy pragmatism

As a fiduciary, we help our clients meet their investment goals by providing many different avenues to invest in energy and infrastructure. We invest on their behalf in both public and private markets, and we see energy opportunities as particularly well-suited for private markets, especially around scaling new technologies.

On behalf of our clients, BlackRock has more than $340bn invested in fossil-fuel companies (with roughly 60% of those investments in the US), as well as roughly $165bn in energy-transition strategies. This mix doesn't reflect our view about where the market should go. Instead, it represents the preferences and decisions of thousands of our clients around the world. Our clients choose their own investment objectives, including mandates to invest in oil and gas or lower-carbon sources of energy, or both, or neither. It's our clients' choice.

Fossil-fuel companies

As of mid-2024, we had more than $340bn invested in fossil-fuel companies, of which about 70% was through our index fund business. Our investments include companies in energy exploration, production, refining, storage, transport, energy equipment, energy services and more.

They also include investments in utilities that rely on both hydrocarbons and renewables. Many traditional energy companies are also investing in lower-carbon energy (such as converting natural gas to blue hydrogen), as well as in carbon capture and storage, drawing on their size, cash flows and knowledge of the energy market.

Renewables

We also help our clients invest in renewables and earlier-stage technologies. We are market leaders in solar and wind, with more than 30 investments in onshore and offshore wind in the US, South Korea, France, Belgium, Spain and other countries, as well as more than 20 investments in solar plants in South America, Asia and elsewhere. We have invested in the public-private finance vehicle behind Africa's largest wind farm, which provides about 10% of Kenya's installed capacity. A BlackRock-led consortium has committed to a $550mn investment in the renewables arm of one of India's largest electricity providers, which invests in solar pumps, rooftop solar infrastructure, utility-scale renewable energy generation, EV charging infrastructure and module manufacturing businesses.

We have joined with a major global technology company to develop a 1GW pipeline of new solar capacity in Taiwan. Our partner will buy energy from the project to meet demand from its data-center and cloud operations there. We have also signed a corporate power purchase agreement with the largest buyer of renewable energy in Taiwan.

Earlier-stage technologies

Our investments in earlier-stage technologies include a giant 'hot rock' battery, which heats up blocks of carbon with wind or solar power during the day and then uses that heat to power giant industrial facilities around the clock. We made this investment through Decarbonization Partners, our joint venture with Temasek. Decarbonization Partners also supports technological innovation at a US-based global leader in 'turquoise hydrogen.'

We are a significant shareholder in a company that focuses on geothermal and recovered energy generation. And we help our clients invest in facilities that convert organic waste and manure into renewable natural gas, addressing problems of both food waste and clean energy production.

Infrastructure for AI

In September 2024 we announced a new partnership to make investments in data centers to meet the growing demand for computing power, as well as energy infrastructure to create new sources of power for these facilities. The partnership will initially seek to unlock $30bn of private equity capital from investors, asset owners and corporates, which in turn will mobilize up to $100bn in total investment potential when including debt financing.

Battery storage

BlackRock has invested more than $1bn across the battery value chain, from manufacturing to deployment, with investments designed to improve performance, efficiency and sustainability. In Australia, we have invested to support the build-out of over 1GW of battery storage assets, including the world's largest grid-scale battery, which will store power from renewable sources at peak production to ensure reliable energy supply throughout the day. This project will address intermittency problems and enhance grid reliability as Australia seeks to shift its power generation mix to more than 80% renewables by 2030. We are also invested in Europe's largest open, high-power EV charging network, operating 1,500 chargers across 24 countries. BlackRock is the lead investor in one of the top three utility-scale battery systems companies in the US, providing stability of energy supply to utilities and regions across the country.

Natural gas pipeline

A BlackRock-led consortium is financing a 4,700+ mile natural-gas pipeline system in Saudi Arabia, which will transport virtually all of the country's natural gas to domestic customers. The largest energy-infrastructure transaction in the Middle East, it will help Saudi Arabia shift its domestic energy mix away from oil toward natural gas and clean hydrogen.

Wind

Some of the investments we have made will help address the intermittency issues that come with renewable power. These include a synchronous compensator adjacent to one of the UK's largest wind farms, which will maintain the voltage levels and electromagnetic frequency that the local grid needs to function smoothly.

Carbon capture

We have invested $550mn in a joint venture to develop the world's largest direct air carbon capture facility, in Texas. Due to begin operations in mid-2025, the facility is designed to capture up to 500,000 tonnes of CO_2 per year. Separately, we have recently invested in a mineralization-based technology in Europe that uses recycled concrete to absorb CO_2 from biogas plants.

> We think private markets can play an asymmetric role in the transition. Decarbonization requires making multiple technology bets, each with technology and timing risk. These are often best done in private markets, through joint ventures with risk-sharing partners.
>
> **Dickon Pinner**
> Head of Transition Capital

Innovative financing solutions will be needed to supply the capital necessary for a doubling of annual energy investment over the next three decades. Here, BlackRock is a market leader in bringing together public and private capital through partnerships and blended-finance vehicles.

These include the Climate Finance Partnership (CFP), a finance vehicle focused on investing in climate-related infrastructure in emerging markets. CFP has invested in a renewable-energy operator and developer in Thailand and a renewable-energy developer in Malaysia.

Alterra, the largest-ever private investment vehicle addressing climate change, awarded a mandate to BlackRock to invest in climate transition projects, including through co-investments, and committed catalytic capital to forthcoming BlackRock-managed blended-finance strategies. Separately, with the support of the government, we launched a New Zealand-focused climate infrastructure strategy to invest in solar, wind, green hydrogen and battery-storage technologies.

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Conclusion

Meeting the world's growing demand for energy – while balancing the needs of security, reliability, affordability and decarbonization – offers significant investment opportunities for years to come. We see an enormous role for capital markets in lowering the cost of capital, and thus the cost of innovation, and in supporting the deployment of solutions at scale.

This creates opportunities for our clients across the energy system. We look forward to working with our clients to achieve their investment goals – and to engaging with policymakers as they develop the environment that will support our clients' investments in energy pragmatism.

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Notes

1. Unless otherwise noted, all historical data in this paper is drawn from the Energy Institute's *2024 Statistical Review of World Energy*.
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3. Joule, *The growing energy footprint of artificial intelligence*, 2023
4. International Energy Agency, *World Energy Outlook*, 2023
5. The IEA's Stated Policies Scenario reflects current policy settings based on policies in place, as well as those under development, as of August 2023. The scenario takes into account currently planned manufacturing for clean energy technologies. In addition, the IEA has modeled two other scenarios: one that represents the achievement of climate pledges, and another that achieves net-zero emissions by 2050.
6. The chart, drawn from our BII Transition Scenario, shows the large uncertainty in demand across different scenarios (bars) for different parts of the energy mix, with uncertainty ranges growing with time. BII's investor-informed view sees near-term growth for most forms of energy with much faster growth for low-carbon sources. We also see more uncertain but eventual and gradual decline in demand for traditional energy sources, as low-carbon sources eventually begin to substitute amidst still-resilient demand in emerging markets and harder-to-decarbonize sectors.
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10. United Nations Environment Programme, *Emissions Gap Report 2023;* IEA, *World Energy Outlook 2023;* IPCC, *Sixth Assessment Synthesis Report, 2023*
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23. Citi Research, *Overcoming Gridlock: Powering Our Future*, 2024
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