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Investment perspectives
Sustainable and transition investing
July 2023

Tracking the low-carbon transition

We introduce the BlackRock Investment Institute Transition Scenario. It's our framework for tracking the transition to a low-carbon economy – one of several mega forces sweeping markets – to help assess the investment opportunities and risks it may bring.

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Introduction

The transition to a low-carbon economy is among a handful of major structural shifts that we see rewiring economies, sectors and businesses. These mega forces, which also include the rise of artificial intelligence and geopolitical fragmentation, are unfolding in decades to come – and are already playing out in markets today. Their effects create complexity, risk and opportunity for companies and investors. Robust research and continuous tracking of these mega forces is necessary, in our view, to assess probable outcomes and help guide investment decisions.

We have created the BlackRock Investment Institute Transition Scenario (BIITS), powered by Aladdin® technology: a research-based, analytical forecast of how the low-carbon transition could unfold. Its value is not in the forecast itself, but how it can be used as a compass to help investors navigate the transition's risks and opportunities. It will not dictate how BlackRock invests client assets. It is the client's choice whether to include the BIITS view into their own investment processes as we recognize views on the transition differ. The BIITS can help inform that choice.

The BIITS focuses on what is most likely to occur – rather than on what anybody thinks should happen or a specific outcome. We have based its key assumptions on rigorous research, and the input of BlackRock's portfolio managers and other experts. The low-carbon transition's speed and shape are highly uncertain. The BIITS cannot capture all the transition's drivers and all the ways physical climate events affect the economy and markets. We approach this process with humility, knowing we may be wrong about some aspects. We aim to monitor how the transition unfolds and plan to recalibrate our views accordingly.

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Summary

- **The transition to a low-carbon economy is one of several mega forces reshaping markets, in our view.** Others include technological innovation, geopolitical fragmentation and aging populations. These structural shifts require in-depth research and constant tracking to help guide investment decisions. We have built the BlackRock Investment Institute Transition Scenario (BIITS) to help assess, on behalf of our clients, how the low-carbon transition is most likely to play out, based on what we know and expect today.
- **We track the low-carbon transition to evaluate investment opportunities relative to what markets have priced in.** The BIITS offers investors a compass to help navigate the transition's risks and opportunities – and should not be relied upon as the sole guide. It's our clients' and portfolio managers' choice whether to use it in their investment processes; we recognize views on the transition differ.
- **The low-carbon transition is a series of profound shifts playing out over decades, reshaping production and consumption and spurring vast capital investment.** We expect adoption of low-carbon energy sources to reach tipping points across regions and sectors when their relative costs fall below those of incumbent sources and when barriers to adoption are low. We distinguish a range of potential catalysts and sticking points that will determine if or when those tipping points are reached.
- **The low-carbon transition is highly uncertain.** Developing a view necessarily requires making key assumptions on how policy, technology and consumer and investor preferences will likely evolve over the coming decades. We plan to adjust as we learn more. Our methodology and assessment of the low-carbon transition's effects are inherently incomplete and highly uncertain, especially further out in the future. We derive our estimates from the models and data sources described on pages 13-16 and caution they may not come to pass.
- **The BIITS distinguishes transition fast lanes, where high levels of decarbonization are likely by our modeling horizon of 2050.** It sees the majority of fast lanes in developed markets (DMs) due to lower costs and a greater share of easier-to-decarbonize sectors. The BIITS places global power generation in a fast lane, and expects it to more than double by 2050 (page 6). It expects regions and sectors that are not in the fast lanes, such as carbon-intensive industry, to face uncertainty due to currently higher costs of capital and technology (pages 7-8).
- **We expect a major capital reallocation, with investment growing rapidly in some areas.** The BIITS estimates investment in the energy system is likely to increase to US$3.5 trillion a year this decade, up from US$2.2 trillion in recent years, and US$4.5 trillion by the 2040s (page 9). It estimates low-carbon investment will account for up to 80% of the total by that time, up from around 60% now. This shows capital investment in higher-carbon sectors is still relevant now and in the future, in our view. Some higher-carbon investments could face transition risk, but we think this can be managed by prudent planning, including diversification.
- **The BIITS expects the low-carbon transition to contribute to inflationary pressures over the next decade via an increasing cost of energy and the capital spending surge** (page 10). How much inflation? That depends on how much central banks lean against it by raising interest rates. The longer-term inflation outlook is more benign. We could see inflation easing as energy prices come back down because of a switch to cheaper renewable energy sources. It could even reverse and become a deflationary force and an economic boost if energy prices fall enough.
- **We see climate resilience emerging as a key investment theme.** The BIITS estimates extreme weather and other climate-related physical damages to economic growth could detract more than 5% from economic activity by 2050 (page 11). It expects most of these losses to occur regardless of how the low-carbon transition unfolds. The transition's speed is likely to become key to mitigating damages only beyond 2050, in the analysis.

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BII Transition Scenario

The transition to a low-carbon economy is unfolding along with other major structural shifts, such as aging populations, accelerating technological innovation, the primacy of geopolitical outcomes over economic ones and a fast-evolving financial architecture. These mega forces all require robust research and continuous tracking to gauge probable outcomes and help guide investment decisions. We focus on what we think is *most likely* to transpire – rather than take a view of what anybody thinks *should* happen.

We expect ripple effects across the global economy, rewiring where revenues and profits are generated across sectors and companies. The pace of change is highly uncertain. That creates complexity, risk and opportunity for companies and investors alike. We believe continuous and systematic evaluation is needed to estimate these changes and assess their implications, rather than rely on periodically available third-party analysis or scenarios that chart a path to a specific outcome, such as net-zero emissions by 2050.

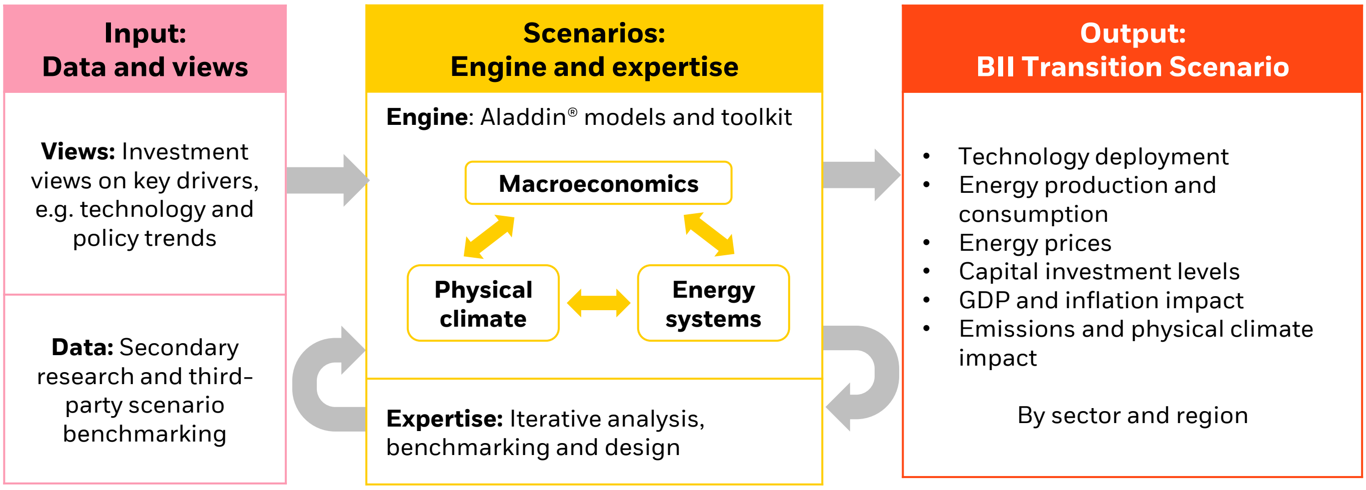
The schematic below outlines how the newly created BIITS, powered by Aladdin® technology, generates insights. Specifically, here is what it is – and what it is not:

- It's our input-driven forecast of how the transition will likely unfold across technologies, sectors and regions – based on assumptions we see as realistic today and informed by the views of BlackRock's portfolio managers. The appendix on pages 13-17 details our estimates, model methodology, underlying assumptions and limitations.
- It's built on a suite of proprietary models that aim to represent the interactions between macroeconomic indicators, evolving energy system mechanics and physical climate feedbacks. It expects economic activity to shift as the cost of higher-carbon energy is likely to rise relative to alternatives, but it also seeks to account for barriers to that.
- It was developed with the help of contextual scenario comparisons, third-party research, feedback from external experts and internal review.
- It is not designed, by its nature, to capture dynamics for individual companies and assets – or assess their opportunities and risks. The BIITS results need to be seen in the context of what's priced in by markets. See page 11. It's meant to be a compass to navigate the low-carbon transition, and cannot be relied upon as the sole guide.
- It can be updated to reflect new developments in policy, technology, and consumer and investor preferences, as well as test real-time shocks. This is necessary as the low-carbon transition is highly uncertain (pages 5 and 12).

Our bottom line: The BIITS aims to help investors navigate the low-carbon transition. It will ultimately feed into the BlackRock Investment Institute's long-term economic and asset return expectations and BlackRock's risk management technology. Will it dictate how BlackRock invests clients' assets? No. The BIITS is a research-based, analytical forecast. BlackRock's portfolio managers can use it as they do other analytics: to stress-test potential scenarios and to bring clarity to their investment processes. And it is the client's choice whether to include the BIITS view into their own investment processes as we recognize views on the low-carbon transition differ.

The making of the BlackRock Investment Institute Transition Scenario (BIITS)

How views, data and model inputs deliver BIITS insights, July 2023



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 (left box) into quantitative inputs for our scenarios modeling (middle box; more details on page 14) to create the BIITS insights (the right box). 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. See a list of data sources on page 16. For illustrative purposes only. Subject to change without notice.

When are tipping points reached?

The low-carbon transition isn't a single trend but rather a complex series of structural shifts in energy, materials, food and land usage toward a low-carbon world. The BIITS's scope is the global energy system – and it sees much of this system moving at different speeds across regions and sectors (pages 6-8).

Our view is shaped by the big technology and energy transitions of the past. Tipping points and rapid adoption have taken place when new technology was perceived to offer greater benefits and ease of use than existing options, relative to their cost. Past examples include electricity supplanting kerosene and cellphones elbowing out landlines.

Tipping points are countered by non-cost sticking points to adoption. They could include policies such as trade protectionism or supply bottlenecks. It is the balance of economic catalysts and the pervasiveness of barriers that we believe ultimately determines the low-carbon transition's speed across regions and sectors.

Tipping points emerge when the relative costs of new technologies fall below that of incumbent ones and where barriers to adoption are minimal, in our view. When they occur, we expect tipping points to result in a steep, S-curve adoption. This is a period of exponential growth soon after the tipping point, which flattens out as adoption becomes more widespread. This has implications for the speed of the low-carbon transition in sectors and regions – and for the revenue and earnings projections of affected companies, both incumbents and challengers.

Tipping points are influenced by three main drivers, as the schematic below shows. First, technology innovation can significantly lower costs and broaden options. Second, government policy can influence costs through taxes or subsidies and indirectly through regulatory standards. Third, consumer and investor preferences shape adoption directly through demand and indirectly through the cost of capital different producers face.

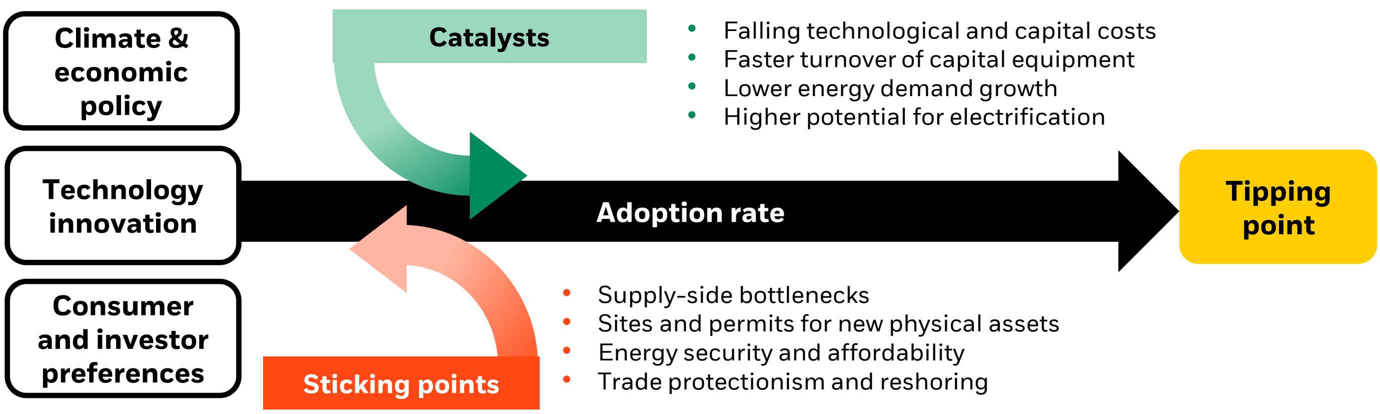
The BIITS places about 40% of global energy-related emissions in a fast lane, where a tipping point has been reached or is likely to be reached in time to achieve high levels of decarbonization by 2050. This includes solar and wind in the power sector and light-duty electric vehicles in transport. The BIITS estimate is based on the model outputs and sources listed on pages 14 and 16, and is in line with analyses from others such as IEA, Systemiq and WRI et al.

In other sectors and regions – where low-carbon technologies face poorer economics or more barriers – the BIITS expects a slower, uneven low-carbon transition and more persistent demand for higher-carbon fuels. Decarbonization could move slowly at first, with tipping points coming later, once low-carbon energy reaches cost parity. That could come through a combination of government policy (low-carbon subsidies or carbon taxes), technological innovation or institutional reforms that lower financing costs. Early adopters may demand new technology before it is at price parity, as seen in many other cases of technology adoption.

In total, the BIITS expects these mechanics to result in a multispeed transition – with uneven progress between sectors and regions. This multispeed nature changes the transition's macroeconomic implications, including the effects of physical climate change (page 10). Understanding the investment implications of the transition requires a view on both the timing of tipping points and whether markets have already priced them in (page 11).

Catalysts and barriers determine tipping points in the low-carbon transition

Our view of the factors that may accelerate or slow adoption of low-carbon energy sources



Sources: BlackRock Investment Institute, July 2023. Notes: The schematic summarizes the BIITS's views of the three main drivers (left) that influence the relative cost of low-carbon energy sources as well as catalysts and barriers hindering their adoption. Tipping points happen, in our view, when relative costs fall below that of incumbent energy sources, and barriers are few or removed. Reshoring is bringing back a business that relocated abroad to the country where it was originally located. For illustrative purposes only. Subject to change without notice.

Key assumptions on uncertain transition

Developing a view of how the transition will unfold and when tipping points are reached requires making assumptions on how technology, policy as well as consumer and investor preferences are likely to evolve over the coming decades. The table below outlines some of the key assumptions that inform the BIITS.

We have based these assumptions on rigorous research and the input of BlackRock's portfolio managers, but we have greater confidence in some than others. We have approached this effort with humility, knowing we may be wrong about some aspects. We aim to monitor the transition outlook over time and plan to adjust our views accordingly.

Policy: There's a strong likelihood of some additional policy support for the low-carbon transition in DMs through 2030, in our view. We expect policy support to expand more rapidly afterward, driven by increased physical climate damages to economic activity and reduced costs of low-carbon technologies. Climate policy developments are intersecting with the rise of green industrial policy in DM countries, in our view. Examples are the Inflation Reduction Act in the U.S. and the Green Deal Industrial Plan in the European Union. We view these as likely to push down costs of low-carbon technologies. EM climate policy, on the other hand, is more uncertain, in our view. Why? It's connected to the availability and cost of capital to finance EM transitions, in our analysis. This is dependent on the highly uncertain reform of multilateral lending institutions.

Technology: We expect the costs of mature low-carbon technology to keep falling as economies of scale and new innovations unfold. We can't predict whether or when breakthrough innovation such as fusion energy or new carbon capture processes might disrupt the energy system. We do see the potential for them to do so in coming decades.

Consumer and investor preferences: The BIITS expects a gradual but uneven shift toward sustainable products, services and assets. For example, it assumes consumers will prefer electric vehicles (EVs) over gasoline-powered cars over time. We think some trends are more likely than others. We have higher confidence, for example, that investor preferences will increase the spread in financing costs between lower- and higher-carbon assets.

Global competition for the supply of traditional and low-carbon energy is crucial to the transition's path, in our analysis. Why? It affects the relative costs and security of energy supply. In oil markets, we expect market concentration to move toward national oil companies and OPEC+ producers, following existing trends. We could also see more clean tech manufacturing away from China in DMs, spurred by DM industrial policy. But we don't expect supply chain concentration for critical minerals to change meaningfully this decade, barring a breakthrough or major discovery.

Overall, we assume mostly equal chances of upward or downward revisions on barriers. This applies in particular to factors such as trade policy and geopolitics and the reform of multilateral development banks.

We think upward revisions are more likely than downward ones when it comes to our expectations for drivers: technology innovation, falling costs and rapid adoption. Our reasoning: Forecasts tend to underestimate innovation and its impact. Upward revisions would likely translate into a transition accelerating faster than our current view. This could help stave off some of the cascading effects of a changing climate, particularly in the latter half of the century.

Views informing the BIITS

Our assumptions on the drivers of the low-carbon transition and our level of confidence around them, July 2023

Driver	Higher confidence	Lower confidence
Policy	Policy ambition grows slowly until 2030. It accelerates after, yet lags in EM. Green industrial policy globally drives demand for climate tech. Russia limits exports of gas to Europe and exports to China. Material shifts in global trade flows.	Pace and mechanism of the evolution of EM climate policy. OPEC+ reaction. Climate litigation risk. Geopolitical fragmentation.
Technology	Costs of mature technologies keep declining. Supply chain issues constrain development and scaling of some key technologies.	Unforeseen breakthroughs in energy technology such as fusion, natural hydrogen or the next shale.
Consumer and investor preferences	A tectonic shift in consumer and investor preferences toward sustainable products and assets. The spread in financing costs between low- and higher-carbon assets widens.	Reform of multilateral banking institutions drives down EM financing costs.

Source: BlackRock Investment Institute, July 2023. Notes: The table lists the drivers we believe to be crucial in the low-carbon transition and an indication of our confidence in selected components of these drivers. **This material represents an assessment of the market environment at the time of publication and is subject to change. Forward looking estimates may not come to pass.**

Transformation of global energy demand

Electrification and decarbonization are set to create a shift in the global energy system, in our analysis. Electrification replaces fuel use with electricity. Decarbonization eliminates carbon dioxide emissions. Replacing an internal combustion engine vehicle with an electric one is electrification. Decarbonizing the miles driven by that car requires charging it with low-carbon power sources. We use the combined share of low-carbon power generation and fuels such as hydrogen and biomass to track the transition's progression. See the dotted area in the left chart below.

The BIITS estimates that lower-carbon energy sources will make up more than half of total global energy demand by 2050, up from an estimated fifth now. See the light yellow and green bars in the left chart below. We think much of the increase will occur due to electrification in the buildings and transport sectors, coupled with decarbonization of the power sector. The shift is primarily driven by falling costs, in our view, supported by policy in many countries. Research from the IEA and Lazard, among others, see renewables as the cheapest source of new power already.

The BIITS expects global power demand to grow 2.5-fold by 2050 and expects power generation to be low-carbon by over 90% then. The reason: The BIITS estimates that more than 80% of new power capacity will likely be low-carbon over the modeling horizon. We also see climate and industrial policy incentives supporting low-carbon fuels like biofuels and hydrogen. We think those could play a role in heavy industries and shipping but see their share of final energy demand in 2050 staying modest at about 15%.

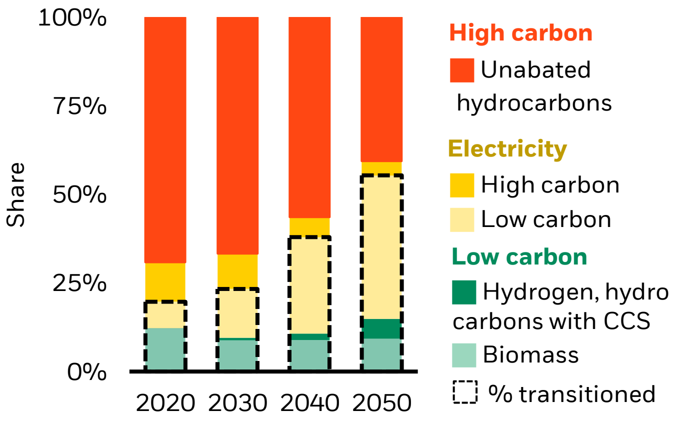
Where does this leave unabated higher-carbon fuels? These are fuels not paired with carbon capture or storage. The BIITS expects them to make up about 45% of global total final energy demand by 2050 (the orange and dark yellow bars in the left chart below), with relatively small changes before 2030. The BIITS expects oil and gas to dominate that share of higher-carbon fuels. It expects a rapid decline in the use of coal in the 2030s and 2040s. One reason: low-cost renewable power takes market share in power generation. See the bottom right chart below.

We see oil and gas playing a role throughout the transition, with demand starting to gradually decline by around 2030. We expect the slide from the peak will be slow as decarbonization in DMs is offset by rising emerging market (EM) energy demand. Demand could be resilient in sectors where there are no economically viable alternatives yet. Examples are sectors that are difficult to electrify, like aviation. Long-term energy storage, high-heat industrial processes and petrochemical inputs all make use of hydrocarbons that are not yet easily replicated with low-carbon solutions.

Minerals are fundamental to the transition, in our analysis. Demand for copper – a key material used in electric grids – is poised to double or triple by 2030 from today's levels, according to a March 2022 IEA study. Surging demand for minerals could likely cause bottlenecks – and potentially slow parts of the transition. Copper shortages are likely to be severe because of the rapid growth of electricity generation we expect, the age of existing electric grids and the long lead times for developing new copper mines. Tight supplies of nickel and lithium could hamper the electric battery supply chain. Yet innovations such as sodium ion batteries could change the composition of demand for mineral inputs without affecting our expectations for the rise of EVs and stationary batteries in the power sector.

Shifting global energy mix

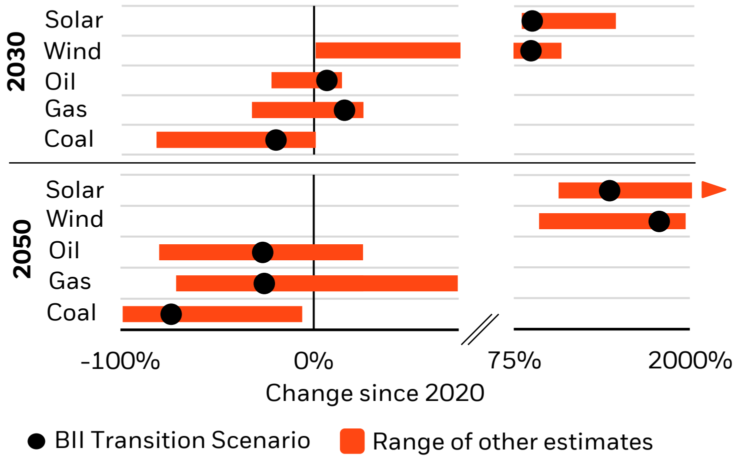
BIITS estimate of final energy demand, 2020-2050



Sources: BlackRock Investment Institute and Aladdin Sustainability Analytics, July 2023. The BIITS estimate is based on the model outputs and sources listed on pages 14 and 16. Notes: The chart shows estimates of the sources of global energy demand between 2020-2050. For instance, it expects electricity generated from low-carbon sources (light yellow) to become the dominant energy source by 2050, replacing unabated hydrocarbons () – or hydrocarbon use with no provision for carbon capture or storage (CCS). Biomass is organic material from plants and animals. **Forward-looking estimates may not come to pass.**

More solar and wind

BIITS estimate of energy changes by 2030 and 2050



Sources: BlackRock Investment Institute and Aladdin Sustainability Analytics, July 2023. Third-party data used to derive the estimates are listed on page 16. Notes: The chart shows our estimate of the change in the source of global energy production in 2030 and 2050 relative to third-party estimates we use as a benchmark. See the "Benchmarking" section on page 13 for specific benchmarks used. **Forward-looking estimates may not come to pass.**

Low-carbon transition: regions

The BIITS estimates the low-carbon transition will likely accelerate more quickly in DMs than EMs, even as individual countries will experience unique transition pathways. Why? It expects policy and consumer/investor preferences to help accelerate a decline in costs and more rapid adoption of low-carbon technologies in DMs. This is driven by factors including lower costs of capital, older higher-carbon assets more likely to be retired, and a lower share of hard-to-abate, or high-cost, emissions due to deindustrialization. The result: tipping points could arrive sooner.

Green industrial policy – or policies aimed at environmental goals – in DM countries is a key factor in our assessment. It is likely to push down the cost of low-carbon technologies – both established and emerging – and accelerating cost advantages over incumbent technologies. Incentives for low-carbon energy sources, sometimes uncapped, could push trillions of dollars or euros of public funds into the energy system. Some DM policy incentives could divert finance to other parts of the global economy. EMs face more barriers broadly – and structurally different transitions than DMs.

Two main catalysts drive the divergent transition speeds between DMs and EMs, in our analysis: cost of capital and demand growth. First, EMs typically face persistently higher cost of capital such as higher borrowing rates. See the left chart below. The reason: perceived country and default risks. Second, industrializing nations with strong growth and booming populations have a bias toward more energy-intensive sectors, with a higher energy intensity of GDP and more energy demand growth. This means EMs have a greater share of slower or uncertain sectors. See the middle chart below. EM energy demand is surging from relatively low per-capita levels today. See the right chart below.

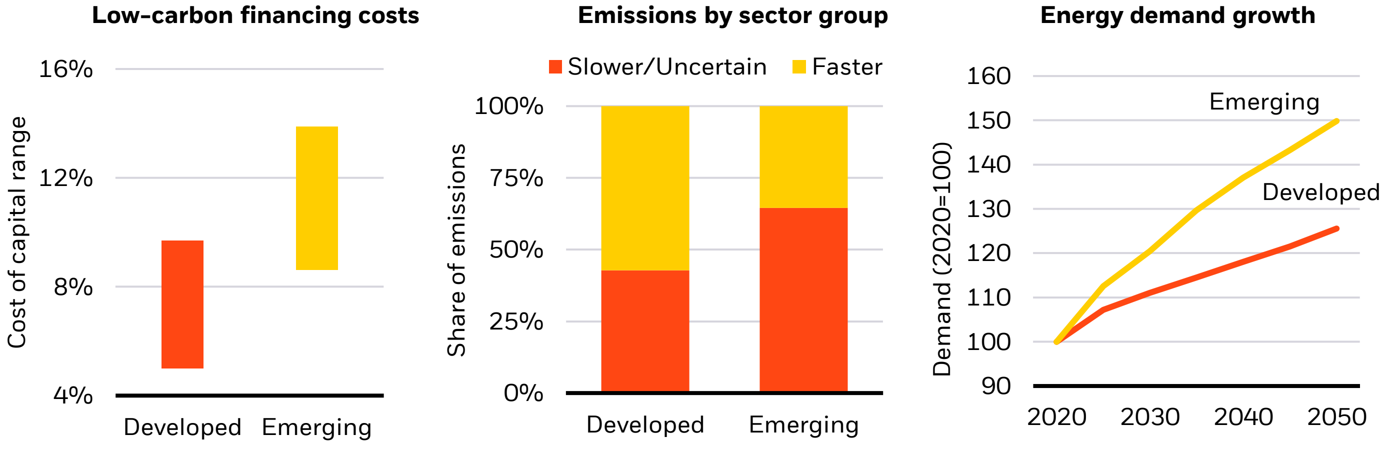
Barriers also may stem from trade protectionism that limits access to low-carbon technology or creates costly supply-side bottlenecks. Plus, EMs each face different development, security, climate and demographic challenges – showing the overlap between different mega forces. For example, many of the world's 46 least developed countries are projected to double in population by 2050, according to the United Nations World Population Prospects report. Finally, EMs are likely to bear the brunt of physical climate change, with the BIITS showing the lion's share of global climate damage to economic activity by 2050 occurring in EMs. See page 10. We expect this to bolster climate resilience, or the ability of regions or companies to effectively manage climate-related risks, as a key investment theme in EMs.

Many EMs lack the fiscal space, in our view, to enter the green subsidy race or bear the high costs for big infrastructure projects. We think that could reinforce the divergence between DM and EM transitions. Potential reform of multilateral development banks could limit that divergence by enabling more transition financing to flow from DMs to EMs. Similarly, structural reforms within EMs could create more attractive investment conditions. These potential EM outcomes may decide the overall speed of the low-carbon transition.

A final note: Our models examine some 16 geographical regions, but we are using the broad DM and EM groupings here to identify overarching trends. This misses the nuanced considerations that could affect the timing and pace of the low-carbon transition at the region or country level. For example, EMs contain both middle income and developing economies, with very different risk profiles and costs of capital. And China's position in the low-carbon transition is unique. Its robust clean-technology industry and fast adoption are likely offset by its sheer size and share of emissions, heavy industrial base and dependence on coal, in our view.

Low-carbon transition dynamics more favorable in DMs than EMs

Cost of capital, emissions by sector group and demand growth by region



Sources: BlackRock Investment Institute and Aladdin Sustainability Analytics, July 2023. Notes: Left chart: Cost of capital is represented as the average of weighted average cost of capital for mitigation technologies in our model, divided regionally by DMs and EMs. Middle chart: Slower/uncertain are sectors with hard-to-abate emissions that are not expected to achieve substantial decarbonization by 2050. Right chart: Energy demand growth is represented as a regionally indexed value of aggregate energy demand on a per capita basis divided by DMs and EMs. **Forward-looking estimates may not come to pass.**

Low-carbon transition: sectors

Which sectors will likely see dramatic changes? We zero in on four that have accounted for the lion's share of energy-related C02 emissions: power, transport, buildings and industry (Minx et al, 2021). That makes them critical to the low-carbon transition. Each is transitioning at its own speed. We derive the BIITS estimates below and throughout this publication from the models and data described on pages 13-16, and caution they may not come to pass.

Power: The BIITS expects rapid electrification to translate into a fast-growing power sector. It estimates electric power will grow about 2.5 times, with relatively small divergence between DMs and EMs. See the left chart below. Why? The costs of renewables and energy storage are likely to decline further, in our view. The BIITS expects remaining higher-carbon power by 2050 to be used as baseload generation by some regions or to balance variable renewable power.

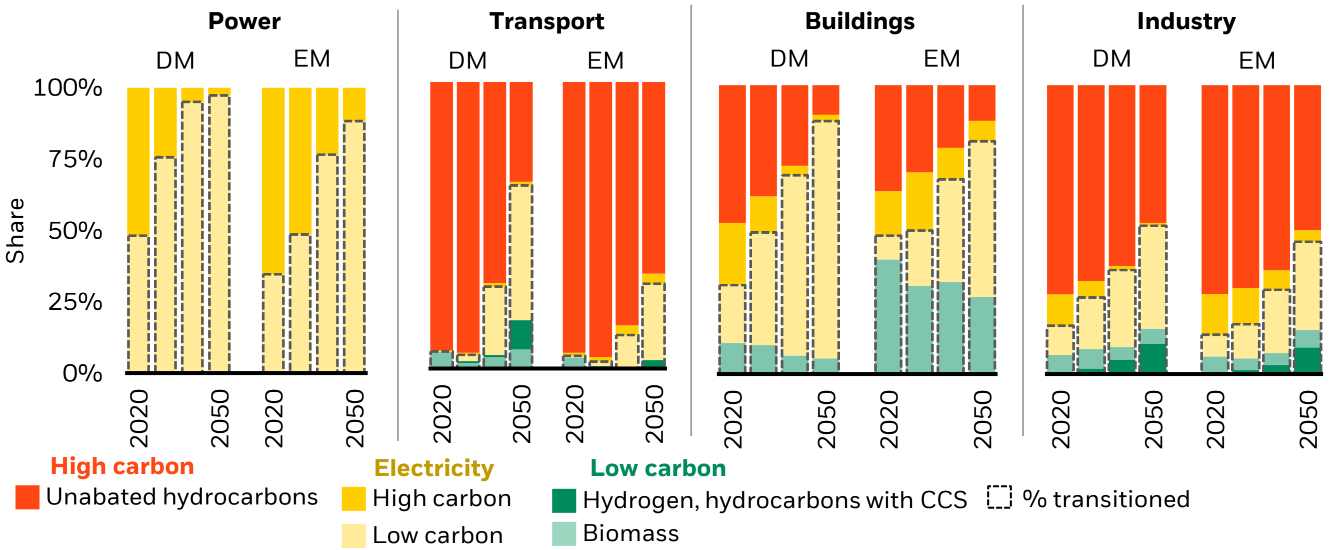
Transport: Sub-sectors here – road, shipping and aviation – are likely to see large differences in transition speed. The BIITS expects nearly all new light-duty vehicles to be electric by 2050, up from less than 4% in 2020. Our reasons: technological advancements and policy, including restrictions on the sale of internal combustion engine vehicles. At least 16 countries, the EU bloc and 10 U.S. states have announced or plan to announce such bans, according to the IEA. The low-carbon transition of heavy-duty vehicles, aviation and shipping could take more time, with full decarbonization likely only after 2050, in the BIITS view. Overall, it sees electricity and low-carbon fuels meeting almost 40% of total transport energy demand in 2050, versus just 5% in 2020. This varies regionally, with about 60% estimated to decarbonize in DMs versus about 30% in EMs. See the second chart below.

Buildings: This sector could transition faster than others. The BIITS expects buildings globally to be on track to have less than a fifth of energy demand met by higher-carbon fuels by 2050. The reasoning: increased energy efficiency as well as use of electricity and low-carbon fuel. It expects growth in the electrification of heating (via heat pumps, for example) over this period. Why? Installation and other costs are likely to decline from "learning by doing," or increased knowledge and efficiencies that come when people perform new activities. Policy also is set to play a role: Selected locales already restrict gas heating and appliances. The BIITs estimates buildings in both DM and EM to reach high levels of low-carbon use by 2050, making for a smaller divergence than in transport. See the third chart below.

Industry: This sector is likely to transition more slowly than buildings, largely due to limitations on the technical viability and cost-competitiveness of low-carbon solutions. The BIITS expects only modest declines in higher-carbon fuel usage by 2050. Electricity could grow its share to 35% by then, but the BIITS estimates unabated hydrocarbons could still meet around half of demand. Hydrogen and carbon capture and storage (CCS) could achieve scale in the 2040s – and maybe earlier on faster-than-expected innovation. The BIITS expects the share of hydrocarbon usage to fall to about half by 2050. See the fourth chart below. And it sees steel production likely achieving large-scale transition only in the 2040s as EMs adopt low-carbon methods. In DMs, the BIITS expects industry use of higher-carbon fuels to start declining this decade. It expects the usage to grow in EMs, peaking in 2030 and then phasing out slowly. Industry demand for energy is dominated by EMs, so we expect the lion's share of higher-carbon demand in 2050 to be there.

Shrinking role of carbon

Estimated shift in power production and energy use in key DM and EM sectors, 2020-2050



Source: BlackRock Investment Institute, Aladdin Sustainability Analytics, July 2023. Notes: The charts show the BIITS estimates of how decarbonization and electrification may play out in selected sectors within DMs and EMs through 2050. The left chart shows how the BIITS expects power generation in DMs and EMs to evolve with low carbon sources (light yellow) gradually taking a larger share of overall electricity production. The next three charts show how the BIITS estimates energy use based on energy source will evolve in three key sectors: transport, buildings and industry. For instance, the BIITS expects transport in DMs to shift from using over 90% unabated hydrocarbon, or fossil fuels, to just 35% by 2050. For EMs that shift is to roughly 70%, the BIITS estimates, from a similar starting point as DMs. **Forward-looking estimates may not come to pass.**

Capital investment on the way

The BIITS expects capital investment into the energy sector to grow to an average of US$4 trillion per year through 2050, an increase from recent average investment levels of US$2.2 trillion a year. See the left chart below. This includes investment in both supply – oil and gas extraction and processing, renewable power plants, electricity transmission and distribution – and demand: automobiles, factory equipment and building energy equipment.

These investments are new capital expenditures (capex) and a reallocation from higher- to lower-carbon capex over time. The BIITS, for example, estimates annual investment in power grids to double by 2030 amid demand growth. It estimates overall investment in the energy system to grow to about US$3.5 trillion a year this decade, initially balanced between higher- and lower-carbon. The BIITS expects the pace to pick up to about US$4.5 trillion a year by the 2040s, with over 80% in low-carbon capex. Higher-carbon investments could become stranded assets, or investments that no longer are able to generate a return if the low-carbon transition were to move faster than we expect. We think these risks can often be managed by prudent planning, including developing low-cost, low-carbon assets that can be retro-fitted.

The BIITS's overall capex estimate is equivalent to more than 2% of global GDP in 2025. The BIITS expects it to moderate to around 1.75% of global GDP by 2050 as renewable and other technology costs decline and the global economy grows. Policy is a key driver of this, we believe, even as many outcomes are possible. Policymakers could provide incentives for low-carbon investment (tax subsidies for renewables as part of the global race for clean tech leadership) and disincentives for higher-carbon use (carbon pricing). Some of these may lead to inefficient use of capital, and could favor certain sectors and companies. Yet we find the incentives overall are likely to accelerate the low-carbon transition – even beyond the borders of the countries providing the incentives.

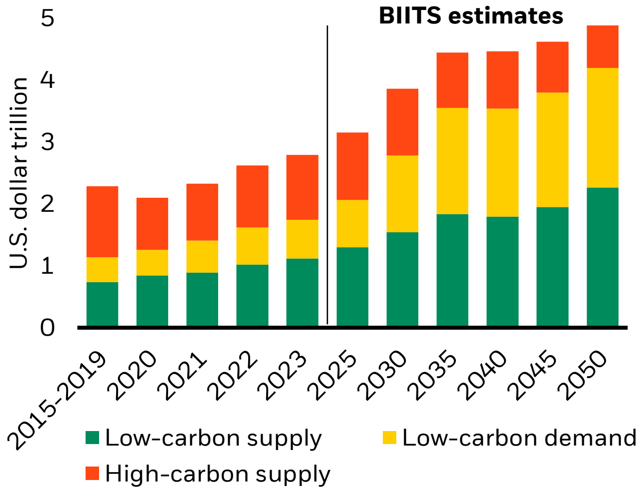
The scope of the BIITS's estimates is limited to energy supply and demand. It expects additional transition-related investment in critical minerals and metals as well as in agriculture, forestry and land use. Demand for critical minerals is likely to at least double by 2040, according to estimates by the IEA and others. See right chart below.

The BIITS's investment estimate differs from others for four key reasons:

1. Estimates differ due to accounting standards. Some account for an entire electric vehicle, for example, while others only count the electric drivetrain and battery pack.
2. Methodologies differ in scope. Some include the agricultural sector or the mining sector, while others don't.
3. We're relatively bullish on technology cost reductions, meaning that the BIITS assumes the overall investment amount in later years is lower than might otherwise be the case.
4. Many existing estimates assume a transition speed consistent with a temperature or emissions *goal*, whereas the BIITS takes into account the *likely* path of the low-carbon transition.

Investment on the way

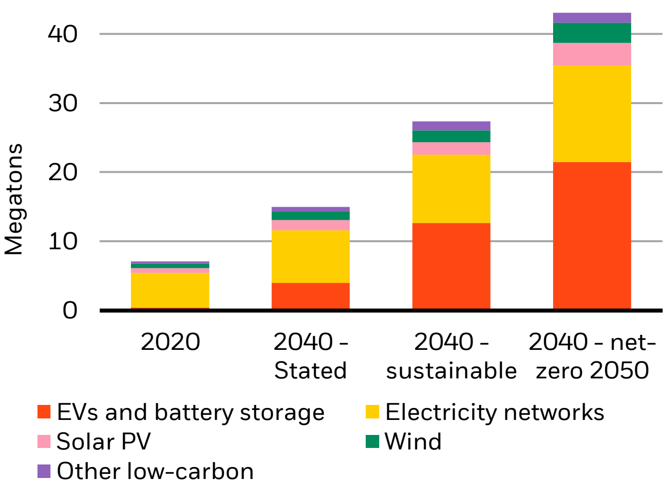
Estimated annual energy sector capex, 2015-2050



Forward-looking estimates may not come to pass. Source: BlackRock Investment Institute and Aladdin Sustainability Analytics, with IEA data, June 2023. Notes: The chart shows the estimated breakdown of capital investment needs – both supply and demand – and the split between high- and low-carbon investments. Amounts are based on U.S. dollar values in 2020. Historical data and estimates through 2023 are based on IEA data. BIITS investment estimates start in 2025.

Minerals needed

Mineral demand for clean energy, 2020 vs. 2040



Forward-looking estimates may not come to pass. Source: BlackRock Investment Institute, with IEA data, July 2023. Note: The charts show the IEA's estimates of demand for selected minerals in 2040 vs. demand in 2020 in three scenarios. The "stated" scenario considers how energy supply evolves without additional steering from policymakers by 2040. The "sustainable" is based on 2040 climate commitments made by governments up to October 2021, and the "net-zero 2050" considers capacity additions needed by 2040 to achieve net zero emissions by 2050. See https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions

Effects on inflation and growth

The BIITS expects the low-carbon transition to contribute to higher energy costs and inflation over the next decade. It also sees a capex surge and additional government spending pushing up activity and adding to inflation pressures. Normally, higher energy costs would depress economic activity and offset some inflation pressures. We expect the capex surge to offset this effect in the transition. See the left chart below.

Higher energy costs present central banks with a difficult choice. Keeping inflation close to their targets entails higher interest rates, not only to offset the investment surge but also to squeeze economic activity to dampen non-energy price pressures. We expect central banks to have a tight policy bias in the years ahead, a sea change from their structural loosening stance during the "Great Moderation" period of steady growth and inflation. We expect the effect to be magnified in EMs because of their higher average cost of capital, as the left chart shows. If the transition were to accelerate, we expect the inflationary pressures to be higher and the trade-off to be sharper still.

Beyond this decade, the inflation and growth outlook is more uncertain. The supply shock is likely to ease as energy prices come back down because of a switch to cheaper renewable energy sources and lower operating costs. It could even reverse and become deflationary, resulting in an economic boost if energy prices fall enough. The BIITS currently does not capture the potential inflationary effects of physical damages: possible scarcity of commodities and food that results in higher prices.

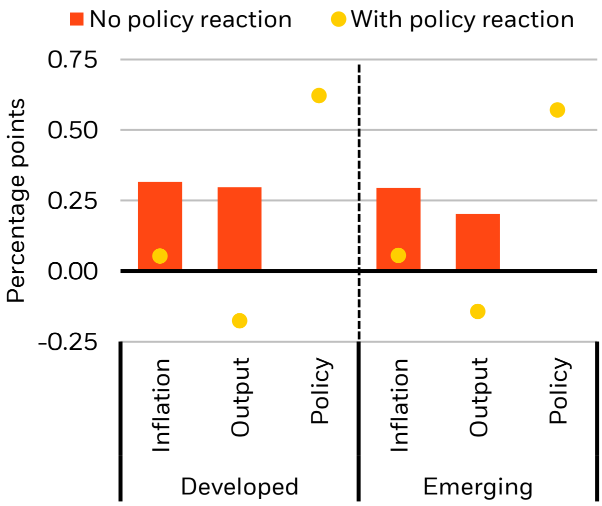
The BIITS expects growth effects to be increasingly dominated by extreme weather events and other climate-related physical damages over time, rather than by transition-related factors. It sees such damages increasing to mid-century and beyond as average global temperatures rise through 2050. The BIITS estimates damages to GDP could amount to more than 5% of annual GDP by 2050. See the right chart below. This takes into account lost output from lower productivity due to a less stable climate, and more frequent destruction of infrastructure and equipment in extreme weather events (Burke et al, 2018). The BIITS estimates most of the expected GDP loss will occur regardless of how quickly the low-carbon transition progresses from here as some level of emissions is inevitable until near mid-century.

The BIITS expects EMs to bear the major share of climate-related GDP losses. Why? Many EM countries are located in tropical latitudes that are vulnerable to climate-related damages. Other reasons include a high reliance on climate-sensitive sectors like agriculture and low resilience to extreme weather events.

The speed of the transition determines the extent of damages further ahead, we believe. Keep in mind that the effects of physical climate change are non-linear. This makes them difficult to predict, especially further out in time. If the world passes more critical warming thresholds, we could see a substantial increase in both climate damages to the capital stock in the economy and the uncertainty around physical climate effects.

Inflation pressure = higher policy rates

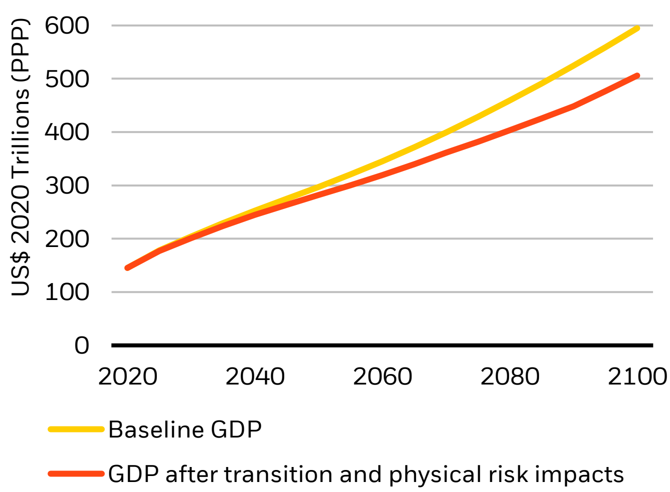
Inflation, output and policy estimated impact, 2020-2030



Forward-looking estimates may not come to pass. Source: BlackRock Investment Institute (BII), with data from Haver Analytics, July 2023. Notes: The chart shows BII's estimates of the impact of the low-carbon transition on inflation and output in DM and EM between 2020-2030 under two illustrative BII scenarios: with and without a monetary policy response (rising interest rates) to higher inflation.

Climate damages set to shrink GDP

GDP before and after climate damages, 2020-2100



Forward-looking estimates may not come to pass. Source: BlackRock Investment Institute, Aladdin Sustainability Analytics, July 2023. Notes: The chart shows evolution of global GDP with the climate damages the BIITS expects (orange), compared with a counterfactual of no damages (yellow). The gap between the orange and yellow lines represents the climate damages we expect. GDP is calculated on a purchasing power parity basis in 2020 U.S. dollars. The baseline GDP value is based on World Bank data, the growth rate on OECD estimates.

Portfolio implications: What's in the price

The BIITS considers long-term, sector-level trends and is not designed to capture dynamics for individual companies or assets. It also does not assess the extent to which markets have priced in the associated risks and opportunities. The BIITS view of the low-carbon transition's path is one piece of the puzzle. The investment implications depend on: 1) how sector and technology trends change where and how revenues and profits are generated across sectors and companies; and 2) whether market prices already reflect these changes.

The BIITS results and estimates, however, can be useful inputs into investment processes. The BIITS aims to identify and size new green segments, thematic opportunities and risks. It can also provide sector-level benchmarks as inputs to financial modeling. As a result, we plan to incorporate the BIITS results into the BII's capital market assumptions (CMAs), the estimates of long-run return and risk that underpin BII's strategic asset allocation views.

From electricity to the automobile to the internet, the emergence of new technology or policy-induced shifts in product or production practices can disrupt entire industries. Our framework for identifying tipping points across segments of the transition helps us identify where and when such transformation may happen. We can anticipate them and respond to them within portfolios as a result.

Changes in technology, policy and consumer/investor preferences can move technologies or sectors from being on a slow, linear path of decarbonization to one that accelerates exponentially when a tipping point is reached. See page 4. Markets could anticipate future earnings growth and price it in before the tipping point is reached, changing the potential investment opportunity.

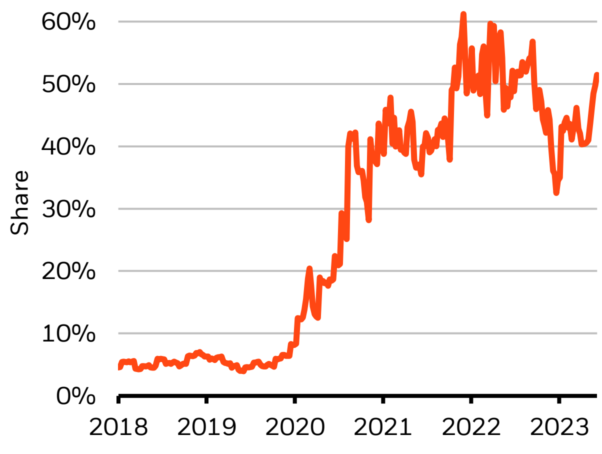
In some cases, valuations can get ahead of themselves, even as transitions continue apace. Case in point: Valuations of electric vehicle companies surged before pulling back in the past year – even as their market share keeps growing. See the charts below. We believe that finding transition-related opportunities that are not priced in yet requires granular analysis as a result.

Transition-related opportunities may also be uncovered in regions and sectors that are not in fast lanes. Examples are diversified, low-cost producers with robust transition plans. Traditional energy players also may outperform at times, notably when there are mismatches between supply and demand, as seen in 2022. Such mismatches are set to become a persistent feature of the low-carbon transition amid underinvestment in higher-carbon energy infrastructure, in our view.

Separately, we see a risk of unintended implications of a multispeed transition for investors with certain types of portfolio decarbonization objectives. If the transition proceeds unevenly between sectors and regions, portfolio decarbonization targets could incentivize a shift in portfolio toward fast-lane sectors and away from others. This could shift exposures in potentially undesired ways for such investors, if not managed through sector or regional constraints or the use of forward-looking metrics.

EV valuations rise and fall ...

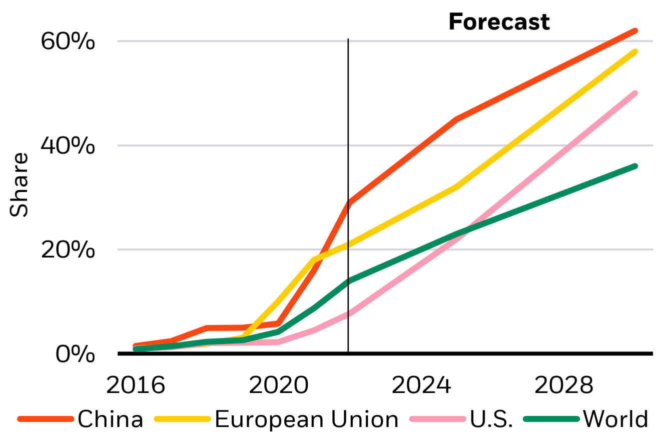
EV company market cap share, 2018-2023



This information is not intended as a recommendation to invest in any particular asset class or strategy. Source: BlackRock Investment Institute, with data from Refinitiv Datastream and MSCI, July 2023. Notes: The chart shows the combined market-cap weight of pure-play EV companies – or companies that only produce EVs – within the MSCI All-Country World Automobiles Index.

... even as EV growth is accelerating

EV sales as share of total car sales, 2018-2030



Forward-looking estimates may not come to pass. This information is not intended as a recommendation to invest in any particular asset class or strategy. Source: BlackRock Investment Institute and International Energy Agency, data as of December 2022. Notes: The chart shows the share of EV sales of total automobile sales in selected countries and regions.

Appendix

Uncertainty and sensitivity tests

Policy and geopolitical developments in the past year underscore how quickly the transition outlook can change and the high degree of uncertainty inherent in its evolution. Historical energy transitions have been non-linear, meaning they can have sudden leaps or unexpected slowdowns. This irregular process makes it difficult to forecast outcomes.

The BIITS aims to capture the impact of the transition on the real economy based on our views of the main drivers. We acknowledge the uncertainty in many areas crucial to the transition. Our methodology and assessment are inherently incomplete and highly uncertain. We recognize views on the low-carbon transition vary because of this uncertainty.

We outlined the big assumptions underpinning the BIITS around policy, tech and consumer/investor preferences on page 6. Upward or downward revisions to those calls could change the central view on the speed of the transition. Here are some of the key uncertainties that could affect those calls over time:

- Major innovation could help mitigate emissions from hard-to-decarbonize sectors. These sectors currently have requirements that make electrification and decarbonization difficult with expected innovation.
- The size and scope of climate policies could increase more than we expect. Conversely, climate policies could be restrained due to goals that potentially conflict with decarbonization, like energy security and affordability.
- We expect the cost of technology to decline, but that may not happen as rapidly as we think.
- The cost of capital could come down if incentives are created for private transition finance in emerging markets, but it could also rise if investment fuels inflation and leads to interest rate hikes.
- Geopolitical fragmentation and conflicts could restrict mineral flows or technology that are critical to the transition.

We tested how sensitive the BIITS's assumptions were to various changes related to these key uncertainties. See the table below. Some areas of uncertainty are outside the current suite of models used. Examples are geopolitical changes, physical climate damages on household wealth or migration, climate litigation, and innovations such as nuclear fusion. "Negative emissions," or carbon dioxide removal, represent another key uncertainty.

We recognize that we won't get everything right – and we can't include all potential factors that would inform our overall view. Our aim is to be roughly right rather than precisely wrong on the parts of the transition that are currently in scope.

Testing key model sensitivities

Sensitivity tests and results

Key uncertainty	Sensitivity tests	Result
Level of climate policy ambition	Varying carbon prices and taxes in the economy and specific sectors.	Higher carbon prices would spur low-carbon technology investment, faster decarbonization, and a decline in oil and gas supply. Lower carbon prices would largely bring the opposite, especially less investment in low-carbon technology.
Pace of technological innovation	Slower near-term cost reductions in mature low-carbon technologies driven by barriers to global trade and protectionism. Faster cost reductions in technologies with a longer time to market driven by technology breakthroughs.	Slowing cost reductions for mature low-carbon technologies would bring a significant increase in emissions and oil and gas supply, and a big reduction in the rate of deployment of EVs. Technological breakthroughs in emerging climate technology would bring modest acceleration to emissions reductions and a modest bump to total cumulative investments.
Cost of capital	Reduction in the cost of capital spread between EMs and DMs post 2030. Interest rate hikes in response to investment boom and other inflationary feedbacks.	Both increases and decreases in weighted average costs of capital had minimal effects on the key metrics in tests.

Source: BlackRock Investment Institute, July 2023. Notes: The table lists three inputs crucial to the transition, examples of sensitivity tests around them and the results of these tests. It represents an assessment of the market environment at the time of publication.

Appendix

Methodology

The BlackRock Investment Institute Transition Scenario is a forecast view of the low-carbon transition, informed by in-house experts and developed using Aladdin Climate's suite of proprietary transition models in partnership with the BlackRock Investment Institute. There are two key steps involved: how we quantitatively implement our *view* of the transition, and the *scenario engine* that underpins it. Both are essential components of the methodology for developing the BIITS and should be considered in tandem. Some of the findings, such as the estimates of expected capital investment in the transition and inflation, are additional analyses using the results from these engines.

Limitations

The BIITS does not exhaustively represent the global energy system, and cannot capture all the drivers of the low-carbon transition and all the ways physical climate events affect the economy. Our methodology and assessment of its effects are inherently incomplete and highly uncertain, especially further out in the future. The BIITS is not designed to capture dynamics for companies or assets, nor does it assess whether markets have priced in opportunities and risks. It is not intended as a recommendation to invest in any particular asset class or strategy or as a prediction of future performance.

The view

The BIITS is driven by the views of BlackRock portfolio managers on what they see as the fundamental drivers of the low-carbon transition. The BlackRock Investment Institute engaged with 80 transition-focused BlackRock portfolio managers and leaders on topics including emissions reductions, regional climate policy ambitions, technology adoption and deployment, cost of capital trends and future technology costs – both for mature (solar, wind, electric vehicles) and emerging (clean hydrogen, carbon capture, sustainable aviation fuel). We incorporate the effects of the transition on growth and inflation, and how central banks could respond. We've supplemented these views with secondary research and consultation. We then benchmark a set of key parameters that drive the BIITS. These fall into the categories of policy, regulation, technology costs, cost of capital and other factors affecting emissions.

Summary of key parameters driving the BIITS

Key choice	Qualitative view
Major market policy incentives	• Green industrial policy subsidies in major economies (U.S., EU and China) drive demand for climate technology and bring forward commercial viability timelines for emerging technologies
Announced and expected regulations	• Technology use and uptake, and resulting changes in consumer/investor preferences, are shaped by policy constraints such as bans and sunsetting in higher-carbon sectors and regions
Other economy-wide climate policy	• Policy ambition increases slowly to around 2030 at separate speeds in DMs and EMs. Beyond 2030, climate events and innovation set the stage for more policy, but EM-DM divergence remains
Technology cost curves & emerging tech	• Mature technology costs will continue to decline towards very low levels • Emerging tech enables further mitigation, particularly where supported by policy today
Cost of capital	• Difference in cost of capital widens between lower- and higher-carbon sectors. Cost of capital differences for EMs and DMs will persist

Source: BlackRock Investment Institute, July 2023. Notes: This material represents an assessment of the market environment at a specific time and is not intended to be a forecast of future events or a guarantee of future results.

Benchmarking

Our modeling environment benchmarks initial results against those from other comparable scenarios from other credible providers. These include the Network for Greening the Financial System Phase II and III, the UN Principles for Responsible Investment Inevitable Policy Response, private sector scenarios such as from Shell and BP where available and the Intergovernmental Panel on Climate Change. This isolates and reveals key differences between the BIITS and others, like the right chart on page 6 shows. It also provides a distribution of possible transition pathways and uncertainty on key parameters. Our database compares BIITS outputs with hundreds of metrics including primary and final energy demand, investment in electricity generation, carbon prices and potential distributions, emissions and more by fuel, sector and year.

Appendix

Scenarios: engine and expertise

Our transition scenario modeling framework, powered by Aladdin® technology, provides an integrated approach to understanding how the low-carbon transition may evolve. It is designed to plot the interactions of the transition on the economy through the impact of changing energy prices and damage caused by physical risks under different emission and temperature outcomes. Two core components make up the modeling framework: the global transition model and macro translation layer.

Aladdin Climate's **global transition model (GTM)** provides a view of how the energy system, its costs and broader emissions can evolve over time, reflecting key technology and resource choices. It provides the majority of BIITS scenario outputs, such as future energy flows, emission levels, technology capacity, energy system costs and energy prices.

- The GTM projects how the global energy system and the consequent emissions may evolve over time. The model seeks to optimize the lowest-cost energy system[1] (supply and demand) under limits such as the pace of new technology deployment and climate policy constraints. Key variables include the level of resource use, technology build and operation, and the transmission of energy products between regions such as the shipping of crude oil. This occurs from resource extraction through to final end-use.
- The GTM uses a wide range of data on energy and emissions technology costs and performance, such as the cost of new wind turbines or electric vehicles. We take into account changing cost profiles and other constraints to reflect on key technology and policy developments, such as limits on the pace of new technology deployment due to supply chain constraints or fiscal incentives provided by climate policies in material countries and regions.

The GTM is linked to the **macro translation layer (MTL).** This allows for a feedback loop between the key climate-related transition developments and the impact on long-term economic growth via three sub-modules:

- **BII macro model:** This is a macro-econometric model that relates GDP to total-factor productivity, labor and capital stock such as factories. Productivity is affected by real energy prices, the relative price of investment and factors such as the level of education in the workforce. It takes the GTM's view of evolving energy prices – a key driver of transition risk – and estimates the impact on GDP across economies. Higher prices lead to lower growth relative to a baseline view of future GDP – and vice versa.
- **Aladdin Climate's physical risk function:** Similar to the BII macro model, this uses forecasts of emissions from the GTM to understand the potential impact of physical risk damage on economic activity. It compares the GTM's implied path of global temperatures with the results of a pre-existing physical risk scenario that correlates physical climate change to economic activity.
- **Energy demand module:** This links the GTM, which takes exogenous energy demand as one of its key inputs, with the impact of the low-carbon transition on long-term economic growth from the BII macro model and Aladdin Climate's physical risk function. It relates future energy demands to different combinations and growth trajectories for GDP per capita, population and rates of urbanization. Projections for the latter two variables are fixed as part of the scenario inputs, while GDP projections evolve from a starting baseline given the changing physical and low-carbon transition risks. The changed GDP trajectory in turn affects future energy demand and the GTM's transition pathway.

Limitations

Even these advanced models cannot account for point-of-no-return changes in the environment or their knock-on effects, nor can they distinguish between a productive recovery from a hazard and a non-productive recovery from a hazard. Additional knock-on effects to economic activity, such as through changes to capital stock, wealth levels and wellbeing, are not captured. Recognizing these limitations, we use our damage models to assess the top-line effect on growth to build a feedback loop between our energy demand growth pathways, resulting emissions and their effects.

The interaction between the global transition model and macro transition layer is updated until an equilibrium is reached – the point when there is no further impact on GDP for a given transition pathway and its knock-on effects.

We use about 150 data sources to arrive at the final transition scenario. See the list on page 16. The key datasets underlying the GTM and the MTL include GDP forecasts from the OECD, energy balances from the International Energy Agency and granular data for energy producing sectors from GlobalData.

1 The GTM is a least cost, multi-period, multi-region, linear optimization model.

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Appendix

Impact on inflation and capital investment

The global transition model and macro transition layer also produce estimates on inflation and capital investment:

Inflation assumptions

- We assume changes in energy prices resulting from the low-carbon transition are causing inflation pressures directly via their impact on the energy component of inflation and indirectly via the pass through to other, non-energy prices.
- We then assume central banks observe past inflation pressures and respond using a standard rule that's commonly used in the literature (Taylor rule). That means central banks respond to above-target inflation by raising interest rates. Higher policy rates in turn dampen inflation and lower growth – and vice-versa for lower rates.
- In addition, capital spending affects inflation through the increased demand for investment. Central banks can respond to this by raising interest rates. If they don't do this, higher capital spending feeds into higher inflation.
- We then calibrate key parameters such as the sensitivities of inflation and growth to policy, inflation pass-through to non-energy prices and the effect of capital spending based on standard literature on inflation (Baba & Lee 2022, Rachel & Summers 2019).

Capital investment assumptions

- The BIITS derives its estimates of transition capital spending from our future technology cost expectations and the physical deployment of energy capacity and supporting infrastructure over time, taken from the GTM.
- We segment the capital investment volumes into supply- and demand-side, and into high- and low-carbon sectors.
- We then assess the marginal increase in energy infrastructure investment in light of the supply of money in the economy to determine whether this amount of elevated investment would increase the cost of capital.

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Appendix

Data sources

The following sources of data were used as inputs into the models described on pages 13-15.

- Airbus
- Alstom
- Argonne National Laboratory
- ATA/Ellondee
- Aviation Services
- Bane NOR
- Boeing
- BP
- Bureau of International Recycling
- Chalmers U
- Columbia - SIPA Center on Global Energy Policy
- Compass International
- CRAVEzero
- Duke University
- ECMWF
- EconnectEnergy
- Efficiency Maine
- EnergieHeld
- EntsoG
- Equinor
- ETH Zurich
- Getting to Zero Coalition (Global Maritime Forum)
- GFEI
- GHG Protocol - WRI / WBCSD
- GIIGNL
- Global Efficiency Intelligence
- Hydrogen Council
- ICAO
- ICCT
- IEA
- IEAGHG
- IFEU
- IIASA
- IMO
- Intergovernmental Panel on Climate Change
- IRENA
- KU Leuven
- Lazard batteries & PNNL PumpHydro/efficiency PNNL
- Madhusudhanan et al.
- Marine Insight
- Mayer_et_all_Macroeconomic Implications
- MDPI - EAF steelmaking profitability
- Mitsubishi
- National Bureau of Statistics of China
- NeocarbonEnergy
- NREL
- OECD
- OICA
- Oliver Wyman
- Oxford University Research Archive
- PNNL
- Power Engineering
- Power Mag
- ScienceDirect
- SeaRoutes
- SINTEF
- Society of Naval Archietects and Engineering
- Solar load profiles
- Tecolote
- Tsinghua Univerisity, Building Energy Research Centre
- UIC
- UK Government
- UNCTAD
- University of Piraeus
- Wartsila
- WEF
- World Resources Institute
- World Shipping Council
- World Steel Association

BlackRock's Long-Term Capital Market Assumption Disclosures: This information is not intended as a recommendation to invest in any particular asset class or strategy or product or as a promise of future performance. Note that these asset class assumptions are passive, and do not consider the impact of active management. All estimates in this document are in US dollar terms unless noted otherwise. Given the complex risk-reward trade-offs involved, we advise clients to rely on their own judgment as well as quantitative optimisation approaches in setting strategic allocations to all the asset classes and strategies. References to future returns are not promises or even estimates of actual returns a client portfolio may achieve. Assumptions, opinions and estimates are provided for illustrative purposes only. They should not be relied upon as recommendations to buy or sell securities. Forecasts of financial market trends that are based on current market conditions constitute our judgment and are subject to change without notice. We believe the information provided here is reliable, but do not warrant its accuracy or completeness. If the reader chooses to rely on the information, it is at its own risk. This material has been prepared for information purposes only and is not intended to provide, and should not be relied on for, accounting, legal, or tax advice. The outputs of the assumptions are provided for illustration purposes only and are subject to significant limitations. "Expected" return estimates are subject to uncertainty and error. Expected returns for each asset class can be conditional on economic scenarios; in the event a particular scenario comes to pass, actual returns could be significantly higher or lower than forecasted. Because of the inherent limitations of all models, potential investors should not rely exclusively on the model when making an investment decision. The model cannot account for the impact that economic, market, and other factors may have on the implementation and ongoing management of an actual investment portfolio. Unlike actual portfolio outcomes, the model outcomes do not reflect actual trading, liquidity constraints, fees, expenses, taxes and other factors that could impact future returns.

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