INFRASTRUCTURE STRATEGY 2023

Building the Green Hydrogen Economy

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BCG + EDHEC*infra*

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Executive Summary

Infrastructure investments are increasingly becoming mainstream. They have emerged as one of the most attractive alternative investments today because data shows that they can withstand inflationary pressures and demand fluctuations better than other kinds of investments can. Although assets under management in the infrastructure industry were only around $0.3 trillion in 2015, they increased over the next seven years to reach $1.1 trillion in 2022—a growth rate of 21%, almost twice the 11% at which investments in all alternative assets grew. The large infrastructure funds got bigger, too; the ten largest funds that closed in 2022 raised $36 billion more that year than in 2021.

As governments try to rebuild the world's infrastructure with an eye toward ensuring a carbon-neutral world, the infrastructure investments market will continue to expand. Several governments have sought to create environments more conducive to private sector investment in infrastructure businesses, especially since public finances are limited. In the US, the Infrastructure Investment Jobs Act (IIJA) and Inflation Reduction Act (IRA), enacted in 2021 and 2022, respectively, will boost infrastructure development. In the EU, the RepowerEU strategy will reduce the region's dependence on fossil fuels. Our studies indicate, however, that the recent rise in infrastructure asset prices—along with the global economic uncertainty and changes in interest rate regimes—has introduced an element of volatility into the market.

The BCG-EDHECinfra study of the risks facing infrastructure investors and the returns that their investments generated found that asset owners did better than asset managers in 2022, and that infrastructure investors in Australia and New Zealand were the best performers geographically. Specialized infrastructure fund managers generated higher returns than multi-asset managers did last year, and UK pension funds topped North American pension funds, global insurers, and sovereign wealth funds.

The study also found that success in the current environment requires fresh approaches to investing and value creation. In fact, an analysis of the drivers of infrastructure investment performance over the past three years indicates that investors' yields came primarily from declining debt and rising price-earnings multiples and that their performance on operational value creation was, at best, mixed.

Going forward, infrastructure funds will invest more in larger projects, which will take longer to evaluate, especially since there is currently a dearth of mega-projects. The larger funds will invest through development platforms, which channel public and private funds into projects that aren't commercially viable. And the smaller funds will specialize by geography or sector. According to a survey that BCG conducted last year, infrastructure asset managers will continue to increase their investments in digital businesses, such as network utilities and data infrastructure, and in sustainable businesses, such as renewable energy. This sector contains both older segments, such as solar power and wind energy, and newer ones, such as hydrogen, which is turning into a lucrative investment opportunity.

In 2021, demand for hydrogen was around 94 million tons, most of it in the form of gray hydrogen, which is produced from methane or natural gas and therefore isn't environmentally friendly. But by 2050, demand for low-carbon hydrogen will approach 350 million tons per annum (mtpa) under a 2°C global warming scenario or 530 mtpa under a 1.5°C scenario. Governments and companies will have to invest approximately $6 trillion to $12 trillion between 2025 and 2050 to produce and transport enough low-carbon hydrogen to meet demand, according to BCG's calculations.

Although investment opportunities will extend across the hydrogen value chain—from feedstock development and generation to hydrogen transportation and storage—$300 billion to $700 billion of that amount must be deployed soon, from 2025 to 2030. At each link in the value chain, the need for capital will vary by geography, with regional economic policies influencing infrastructure investors' choices. Crucially, four novel strategies can help infrastructure investors gain first-mover advantage in the hydrogen industry.

Infrastructure Investing Is Changing

Infrastructure investments are an attractive alternative investment opportunity today. As economic imperatives, novel technologies, and unprecedented societal challenges catalyze the building of tomorrow's infrastructure, these forces have provided infrastructure investors with gale-force tailwinds.

In the future, however, infrastructure investing is likely to be rather different, with the traditionally steady market shaken by the structural shifts in the global economy. When BCG and EDHECinfra teamed up for the second consecutive year to study the risks and returns that infrastructure investors generated in 2022, it quickly became evident that this dynamic investment environment demands innovative approaches for success.

In many instances, depending on the underlying assets, infrastructure investments don't move in the same direction as other assets when economic conditions change. That's because infrastructure investments tend to be more resilient in the face of inflationary pressures and fluctuations in demand. Those characteristics made them highly desirable investment propositions in the aftermath of the COVID-19 pandemic, which was marked by increased inflation, supply chain breakdowns, and rising interest rates, and led to stagflationary conditions and falling equity markets.

Russia's invasion of Ukraine, which has disrupted the global hydrocarbon economy, and rising environmental, social, and governance concerns worldwide—which are particularly relevant to infrastructure businesses—have further increased interest in the sector. In fact, competition for infrastructure assets is growing at such a pace that only investors with the right strategies will be in a position to capitalize on future opportunities.

Policy Will Drive the Future

Investor interest in infrastructure has risen sharply in recent times. According to a BCG analysis of data from the London-based investment data company Preqin, infrastructure assets under management rose from just $0.3 trillion in 2015 to as much as $1.1 trillion in 2022—a compound annual growth rate (CAGR) of 21%, compared to a CAGR of 11% for investments in all alternative assets. Specifically, infrastructure investments rose in volume by 23% from 2018 to 2021 while those in private equity and real estate, for example, grew by only 17% and 12%, respectively, during the same period. (See Exhibit 1.)

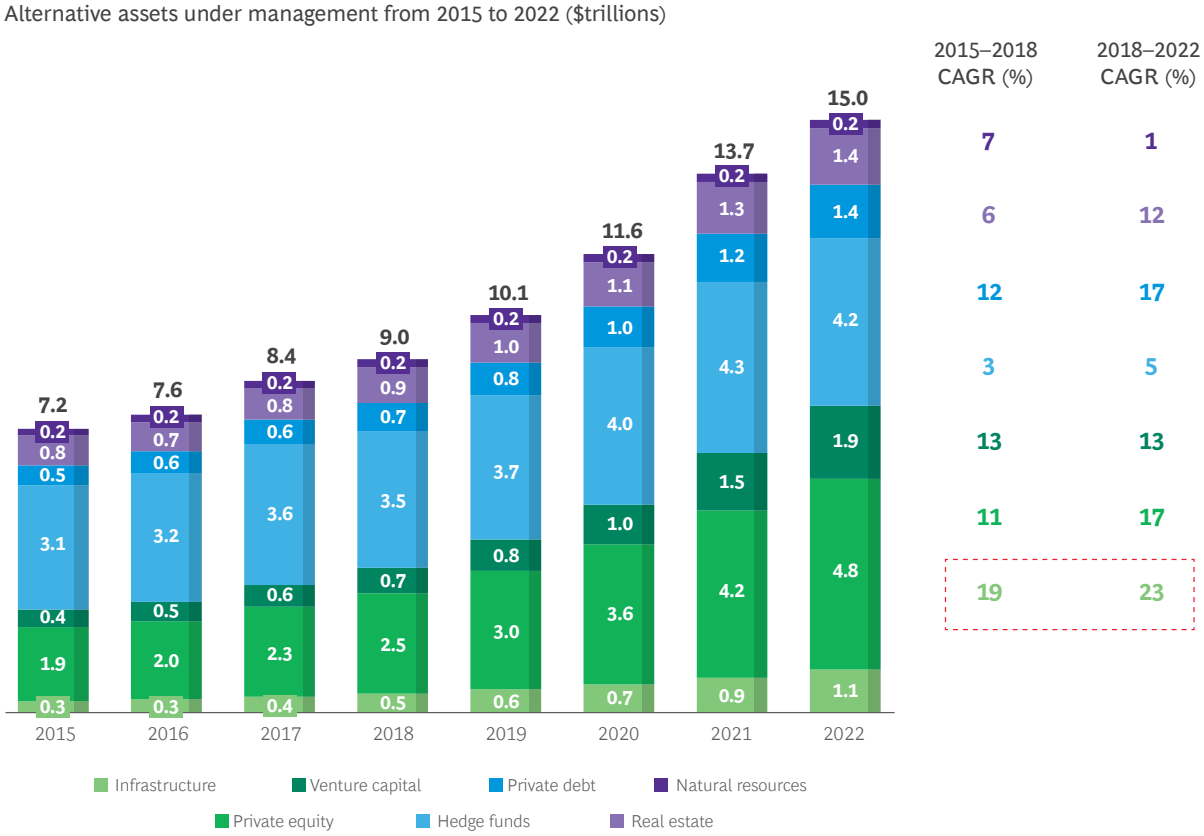
A convergence of several trends, some old and some new, will continue to drive infrastructure investments. In the long run, a vast amount of capital must be deployed to build developed countries' digital infrastructure, decarbonize their energy sources, and rebuild their utilities. In the developing world, investments will be needed to provide basic infrastructure such as drinking water, housing, sanitation, and transportation, especially in fast-growing cities.

Both developing and developed nations need to meet their sustainable development goals, too, and the financial costs of those goals are estimated at from $5 trillion to $7 trillion a year for the period from 2020 to 2030. In 2015, the global forecasting firm Oxford Economics estimated that infrastructure investments needs would total $94 trillion from 2016 to 2040, a yearly average of $3.7 trillion—and about 20% higher than the amount then being invested. This infrastructure challenge comes at a time when most governments have already taken on historically high levels of debt, following the COVID-19 pandemic and the economic shutdown it caused.

Shrinking and aging populations, expanding social entitlement programs, and an extended period of low interest rates have also fostered unprecedented government deficits in the US and many European countries. As a result, governments have limited finances at their disposal to meet infrastructure needs. To replenish their coffers, they must either sell old assets or seek financing for new projects from private investors. Both options will create fresh opportunities for infrastructure investors. Indeed, it is essential for infrastructure businesses and funds to step in to bridge the growing gap between the demand for capital in the infrastructure sector and the available supply of it.

Many governments are determined to create a conducive environment for private sector infrastructure investment. In the past two years in the US, the Biden Administration has overseen the enactment of two laws—the Infrastructure Investment Jobs Act (IIJA) of 2021 and the Inflation Reduction Act (IRA) of 2022—that will boost infrastructure development in the country. The IIJA has budgeted $1.2 trillion for infrastructure spending, $550 billion of it for creating new infrastructure, and the IRA has earmarked $400 billion for energy-related spending.

Exhibit 1 - Infrastructure Is the Fastest-Growing Alternative Investment Class



Sources: Preqin reports; Pitchbook data; expert interviews; BCG model; BCG analysis.

Notes: Because of rounding, not all segment totals add up to the figures at the tops of the bars.

On the other side of the Atlantic, the EU is executing its RepowerEU strategy to reduce member nations' dependence on fossil fuels. This initiative will require €300 billion more in infrastructure spending than originally budgeted, and the difference must come from private investments. In keeping with that expectation, about 30% of limited partners responding to a BCG survey in 2022 said that they will invest more in infrastructure funds over the next three to five years.

Novel Investing Approaches Are Emerging

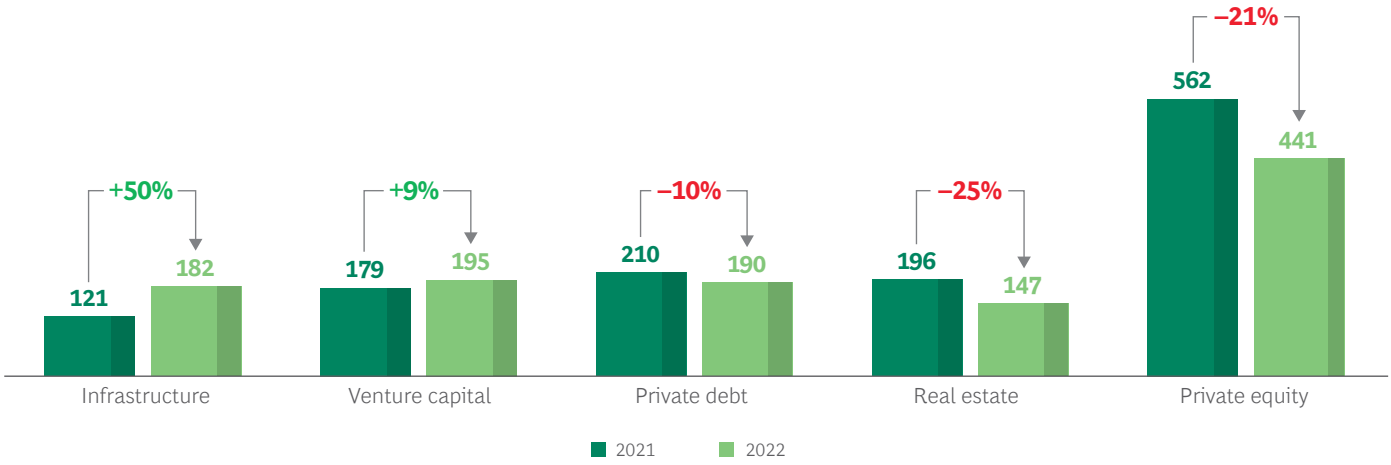
In 2022, infrastructure fundraising grew by 50% over the previous year, while funds that invest in other alternative assets—such as real estate (25%), private equity (21%), debt (10%), and venture capital (9%)—grew at a significantly slower pace. (See Exhibit 2.)

The larger infrastructure funds attracted most of the money last year. The ten largest funds that closed last year raised an additional $36 billion—a year-on-year increase of approximately 60% over the amount that the ten largest funds of 2021 raised. Moreover, the amount of capital committed to infrastructure funds but not yet invested (which we call *dry powder*) reached a record level of $346 billion in 2022, up from $298 billion in 2021, suggesting that there is more money than there are investable projects at present.

The sharp increase in capital invested with the infrastructure funds is bound to affect future investment strategies. The infrastructure funds will try to invest the vast sums of money they've raised in larger and more complex projects, which take more time to identify, develop, and evaluate. And because of the dearth of investable mega-projects at present, competition for infrastructure assets will intensify, driving up valuations. To cast a wider net for investment opportunities, investors are likely to expand their definition of infrastructure to include sectors such as higher education, medical diagnostics, industrial infrastructure, and aquaculture.

Exhibit 2 - Infrastructure Attracted the Most Capital for Alternative Investments in 2022

Global fundraising by asset class ($billions)



Source: Preqin reports, based on data available as of October 2022.

Give the current state of the infrastructure market, investors have no choice but to develop and deploy novel strategies. The larger funds will be hard-pressed to invest because of the scarcity of suitable assets and the emergence of competition from corporations. Many infrastructure companies have already privatized, reducing investors' options. Some infrastructure giants, such as traditional energy companies, are trying to diversify into new sectors, such as renewable energy, which may present viable investment options.

Many large infrastructure funds will invest in projects through development platforms, which can combine concessional public funds with commercial funds to channel financing to investments that may not be viable on purely on commercial terms. The smaller funds, in contrast, are likely to specialize by geography or sector in order to remain relevant in an increasingly competitive market.

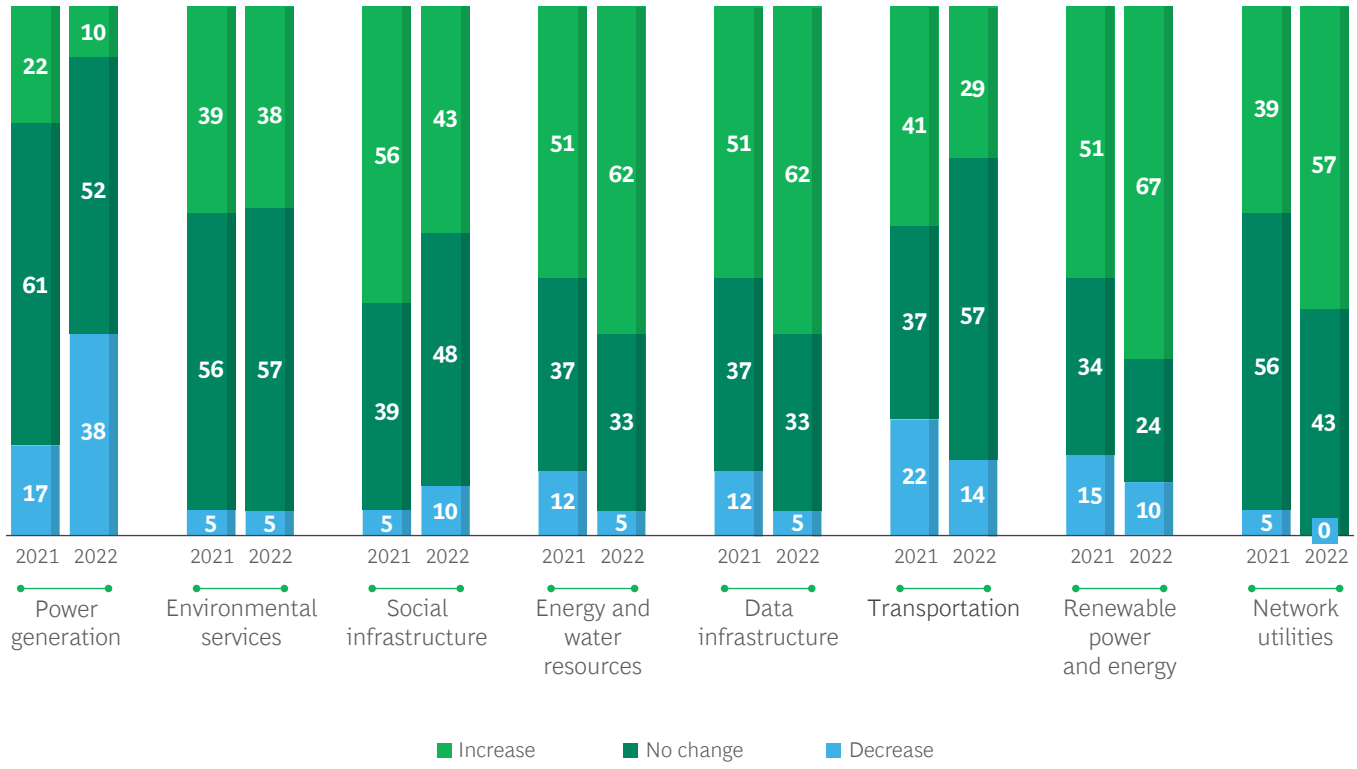
A global survey of infrastructure funds that BCG conducted in the third quarter of 2022 found that general partners and limited partners remain on course to increase their investments in digital businesses such as network utilities and data infrastructure, as well as in sustainable businesses such as renewable energy producers. In fact, the energy transition already underway could attract the largest segment of future infrastructure investments.

Infrastructure fund managers evinced the greatest interest in renewable energy in BCG's survey, with 62% of the general partners saying that they plan to increase their investments in that sector over the next three to five years. (See Exhibit 3.) The renewable energy sector comprises some relatively mature businesses, such as solar power and wind energy, and some new ones, such as hydrogen. Chapter 3 of this report offers a deep dive into the hydrogen industry and the opportunity it represents for infrastructure investors.

Despite the pressure generated by all of the capital raised in the sector in recent years, and despite the ongoing challenges to the global economy, including market volatility, infrastructure seems likely to remain a promising avenue for institutional investors in the short and long terms. But only fund managers that understand the emerging challenges and develop suitable strategies to manage them will generate superior returns from their investments in infrastructure assets.

Exhibit 3 - In the Near Term, Infrastructure Investors Will Focus on Data, Energy and Water, and Renewables

Fund managers' likely investments by sector over the next three to five years (%)[1]



Sources: EDHECinfra and BCG Infrastructure Study 2022; BCG analysis.

Notes: Based on surveys of 63 general partners In 2021 and 68 general partners in 2022. Because of rounding, not all bar segment totals add up to 100%.

The 2022 Infrastructure Investors Leaderboard

When a rising tide lifts all boats, it's tough to figure out which vessels are performing better or worse than others. That's the current state of the global infrastructure investments industry, which raised as much as $182 billion in 2022—a record 50% more than the $121 billion it attracted in 2021.

Although infrastructure investors are flush with funds, it isn't clear which of their strategies performed best last year as the post-pandemic global economic recovery slowed, stagflation set in, and the stock markets stalled. Identifying winning strategies is critical. Not only do they shape tomorrow's expectations for risk and returns, but also they play a key role in marketing opportunities to investors that are looking for specific kinds of exposure in the infrastructure investments market.

To identify 2022's leaders in infrastructure investing, BCG and EDHECinfra teamed up to calculate the risk-adjusted returns that infrastructure investing firms generated and to identify the best performers. We ranked investors within four broad groups of comparable investors: global peer groups, groups by location, asset manager types, and asset owner types. The grouping enabled us to compare investors of different sizes, from different geographies, with different investment strategies, and following different purposes or governance systems.

The size of our data set increased by 90% over the past year, from 359 investment portfolios in 2021 to 681 in 2022. The difference in size between the two samples introduces some caveats with regard to direct year-on-year comparisons. Nevertheless, by using risk-adjusted numbers and focusing on intragroup differences, rather than on differences across groups, our analysis yields a number of meaningful conclusions.

Infrastructure weathered the storm in 2022 better than other asset classes, we found. Among global peer groups, asset owners outperformed the asset managers in 2022. Meanwhile, geographically, infrastructure investors based in Australia and New Zealand performed best, followed by UK investors and by Asian investors, a new addition to the study. (See Exhibit 4.)

In the asset manager category, specialized infrastructure fund managers generated higher returns than multi-asset managers did. And UK pension funds toppled their North American counterparts from their leadership perch in the asset owners group. Sovereign wealth funds followed closely behind the top two, slipping a notch from their second place finish in 2021.

An analysis of the drivers of infrastructure investments' performance over the past three years yielded one particularly striking conclusion: Infrastructure assets' strong performance came mainly from deleveraging and from the expansion of price-earnings multiples, not from operational value creation, which investors are likely to focus on in the future.

How Infrastructure Investments Performed in 2022

It's instructive to look at the performance of infrastructure assets as a class before delving into the investor rankings. To assess the peer groups' average performance, our study used an all-investor group benchmark. The resulting performance numbers extended across a range of risks and returns around this benchmark. Groups with a higher risk profile benefited by seizing some or all of those opportunities and were rewarded with higher returns despite the risks. (See Exhibit 5.)

Even in last year's volatile market, infrastructure investments performed better than all the other alternative asset classes on a marked-to-market basis, although the average return of 0.68% for all peer groups was substantially lower than the corresponding return of 9.65% in 2021.

When we conducted a value decomposition analysis for 2022, the explanation for that immediately emerged. The rise in interest rates—which affected discount rates, valuations, and contracted multiples—was the primary reason for the lower returns. Interest rates increased by more than 250 basis points, causing the peer groups' valuations to fall by 16% on average.

With inflation rising, the projected cash flows of all infrastructure investment groups rose, too, lifting their valuations, on average, by 3% in our model. Infrastructure assets also benefited from their relative insulation from inflation. This protection, along with the initial postcrisis recovery, offset almost half of the adverse impact of higher interest rates on valuations in 2022.

Meanwhile, equity risk premiums, after rising sharply in 2020 because of the COVID-19 pandemic, dropped by 50 basis points in 2022, increasing valuations by 6%. In fact, viewing the data through a medium-term lens reveals that during the three-year period from December 31, 2019, to December 31, 2022, infrastructure remained an attractive investment, delivering cash yields and valuation increases.

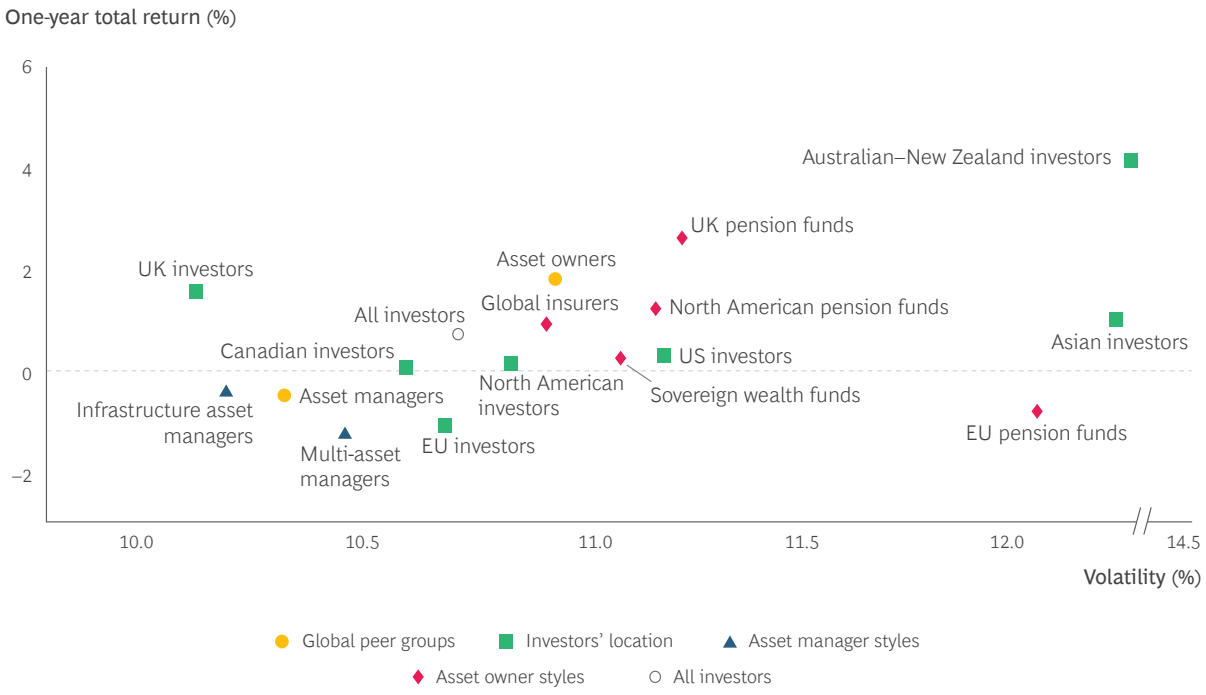
Exhibit 4 - The 2022 Infrastructure Investors Leaderboard

Peer group	Rank	One-year total return (%)	Annualized three-year total return (%)	Volatility (%)	One-year Sharpe ratio
Global peer groups					
Asset managers	2	–0.51	6.61	10.34	–0.05
Asset owners	1	1.81	7.68	10.96	0.17
Investors' location					
Asian investors	3	1.02	10.27	12.24	0.08
Australia–New Zealand investors	1	4.16	9.91	14.36	0.29
Canadian investors	6	0.07	6.90	10.62	0.01
EU investors	7	–1.09	5.72	10.71	–0.10
North American investors	5	0.12	8.55	10.86	0.01
UK investors	2	1.56	7.39	10.14	0.15
US investors	4	0.30	11.42	11.21	0.03
Asset manager styles					
Infrastructure asset managers	1	–0.37	6.33	10.21	–0.04
Multi-asset managers	2	–1.20	6.57	10.48	–0.11
Asset owner styles					
European Union pension funds	5	–0.81	7.39	12.06	–0.07
Global Insurers	3	0.92	6.58	10.94	0.08
North American pension funds	2	1.22	9.22	11.19	0.11
Sovereign wealth funds	4	0.24	8.32	11.11	0.02
UK pension funds	1	2.62	11.25	11.25	0.23
All investors	–	**0.68**	**7.36**	**10.74**	**0.06**

Source: EDHECinfra and BCG survey, infraMetrics 2022.

Note: Data reported is as of December 31, 2022. Annualized total returns include cash yield and capital growth. Peer group rankings are by category.

Exhibit 5 - Comparison of the Risk-Return Profiles of Infrastructure Investors by Peer Group



Source: BCG and EDHECinfra analysis.

Note: Data reported is as of December 31, 2022.

The Drivers of Value

Although infrastructure investments outperformed other alternative asset classes in 2022, their returns were still much lower than in 2021. The main reason for the lower returns was higher interest rates, which affected discount rates and valuations. Still, many infrastructure investments benefited from their insulation from inflation.

By using a value creation bridge analysis, we can trace the value that an infrastructure investor creates in terms of its three components: debt paydown; profit growth, as measured by EBITDA; and price-earnings multiple expansion. Such an analysis reveals how much each element has added to or subtracted from the growth of the portfolio, from entry to exit of the investor. It pinpoints the drivers of the returns on investments purely from the perspective of valuation growth, and it offers insights into investors' underlying assumptions when entering and exiting deals.

A three-year value creation analysis for the period from December 31, 2019, to December 31, 2022, shows that infrastructure delivered an annualized total return of 7.36%, including both cash yields and valuation increases. Looking at the valuation increase in isolation, we found that infrastructure investors saw a cumulative value creation of 9.6%, on average, over the three-year period (excluding the distributions made over the period.) A spread of 9 percentage points separated the groups that saw the greatest amount of value creation from those that saw the least. (See Exhibit 6.)

The record of value creation shows, first, that virtually all groups' investment profits fell during the period. The only exceptions were Asian and US investors, mainly because of their large exposure to oil and gas companies. Other investments, especially in the transport sector, earned lower profits due to the lingering effects of the COVID-19-induced economic downturn. Despite a significant drop in revenues during the pandemic, infrastructure investments have mostly recovered. Still, their earnings were lower than in 2019, causing peer groups to lose, on average, 3% of the value of their portfolios.

Second, by reducing the net debt on their books, investors increased the value of their holdings across the board by 3% over the past three years. And third, the expansion of price-earnings multiples was the biggest cause of value creation over the three-year period, averaging 9% across all 16 groups' portfolios.

Exhibit 6 - How Infrastructure Investors Created Value, 2019–2022

Peer group	Debt paydown (%)	EBITDA growth (%)	Multiple expansion (%)	Total value creation (%)
Global peer groups				
Asset managers	3.3	–2.7	8.3	8.9
Asset owners	3.2	–2.2	9.1	10.2
Investors' location				
Asian investors	1.5	2.9	2.8	7.2
Australia–New Zealand investors	7.7	–13.1	19.3	13.9
Canadian investors	4.4	–2.9	8.8	10.3
EU investors	2.9	–4.3	9.7	8.3
North American investors	3.7	–0.5	7.4	10.6
UK investors	2.3	–0.6	4.2	5.9
US investors	3.1	0.8	6.0	10.0
Asset manager styles				
Infrastructure asset managers	3.0	–1.0	5.4	7.4
Multi-asset managers	4.0	–4.4	10.2	9.8
Asset owner styles				
European Union pension funds	3.4	–6.6	12.9	9.7
Global Insurers	2.1	–0.2	5.9	7.8
North American pension funds	3.1	4.0	3.7	10.9
Sovereign wealth funds	2.5	–0.3	7.9	10.1
UK pension funds	1.4	–0.7	4.2	4.9
All investors	**3.3**	**–2.7**	**9.1**	**9.6**

Source: BCG and EDHECinfra analysis.

Note: Data reported is as of December 31, 2022, and represents the capital growth portion of total returns, excluding cash yield. Values are presented on a cumulative basis for the period from 2019 to 2022.

The 2022 Infrastructure Investors' Leaderboard

Against that backdrop, let's turn to the comparative performance of the peer groups on the basis of their risk-adjusted returns in 2022 (See the sidebar, "How We Rank Infrastructure Investors.") Our analysis reveals the winners in four meta classifications.

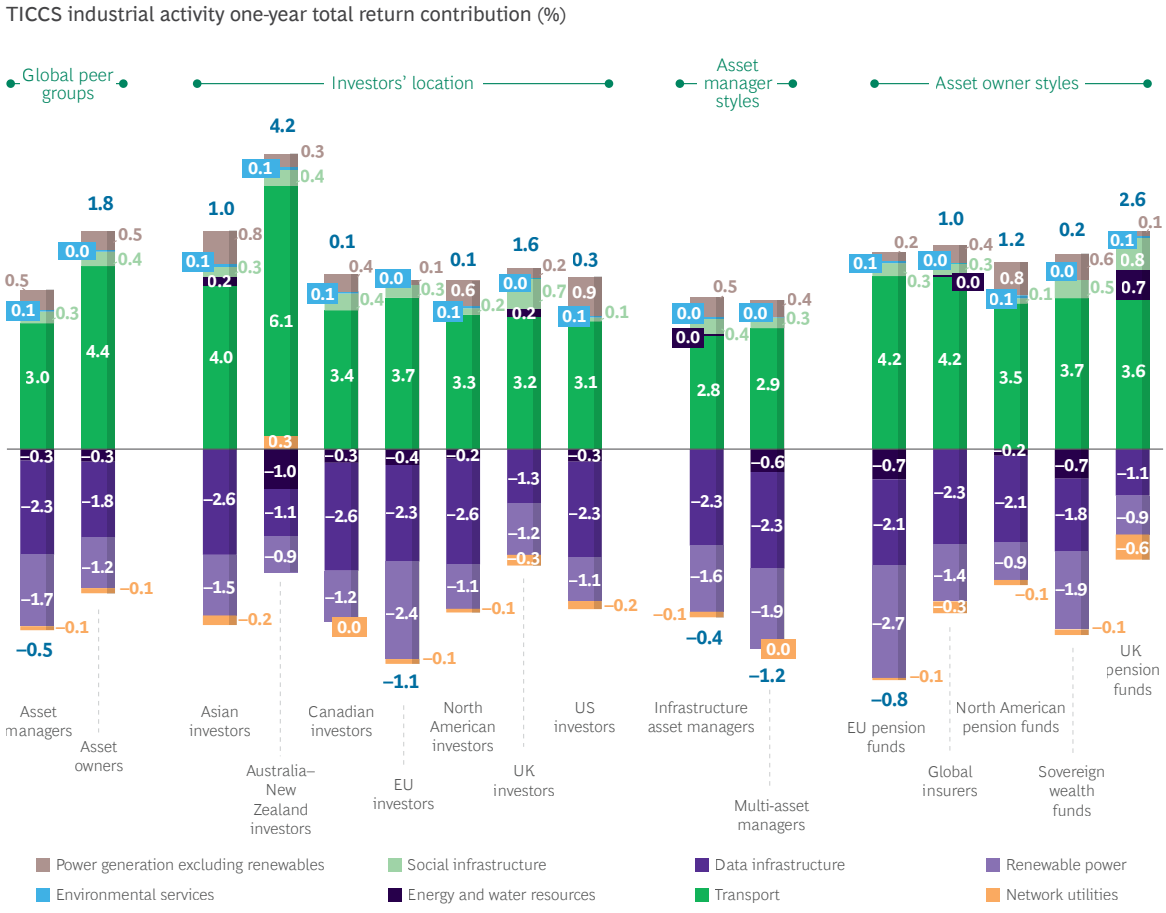
Global Peer Groups

Broadly, there are two global peer groups: asset managers, or general partners such as private equity funds; and asset owners, or limited partners such as pension funds, endowments, and sovereign funds.

Portfolio Allocation. In 2022, asset managers had over half of their portfolios invested in the renewable power and transportation sectors, suggesting that they were focused investors. More than 60% of their investments involved contracted businesses—infrastructure providers with long-term revenue agreements to deliver services—and project-financed companies accounted for more than 70% of their portfolios. Although asset owners had a higher preference for pipelines and merchant businesses, their allocations were otherwise in line with those of asset managers. (See Exhibits 7, 8, and 9 for presentations of the investments of all the peer groups by industry, business model, and corporate structure.)

2022 Performance. Asset owners, generated a one-year return of 1.81% and outperformed asset managers by 232 basis points in 2022. The ten-year volatility level was about the same for both groups, albeit a trifle higher for asset owners. Asset owners allocated 6% more to merchant (revenue-sharing) opportunities than asset managers did, and they reaped the rewards of that higher exposure, despite suffering m 2022 Performance. Asset owners, generated a one-year return of 1.81% and outperformed asset managers by 232 basis points in 2022. The ten-year volatility level was about the same for both groups, albeit a trifle higher for asset owners. Asset owners allocated 6% more to merchant (revenue-sharing) opportunities than asset managers did, and they reaped the rewards of that higher exposure, despite suffering more from the impact of higher interest rates on long-duration investments.

Exhibit 7 - Peer Group Returns by Industry in 2022

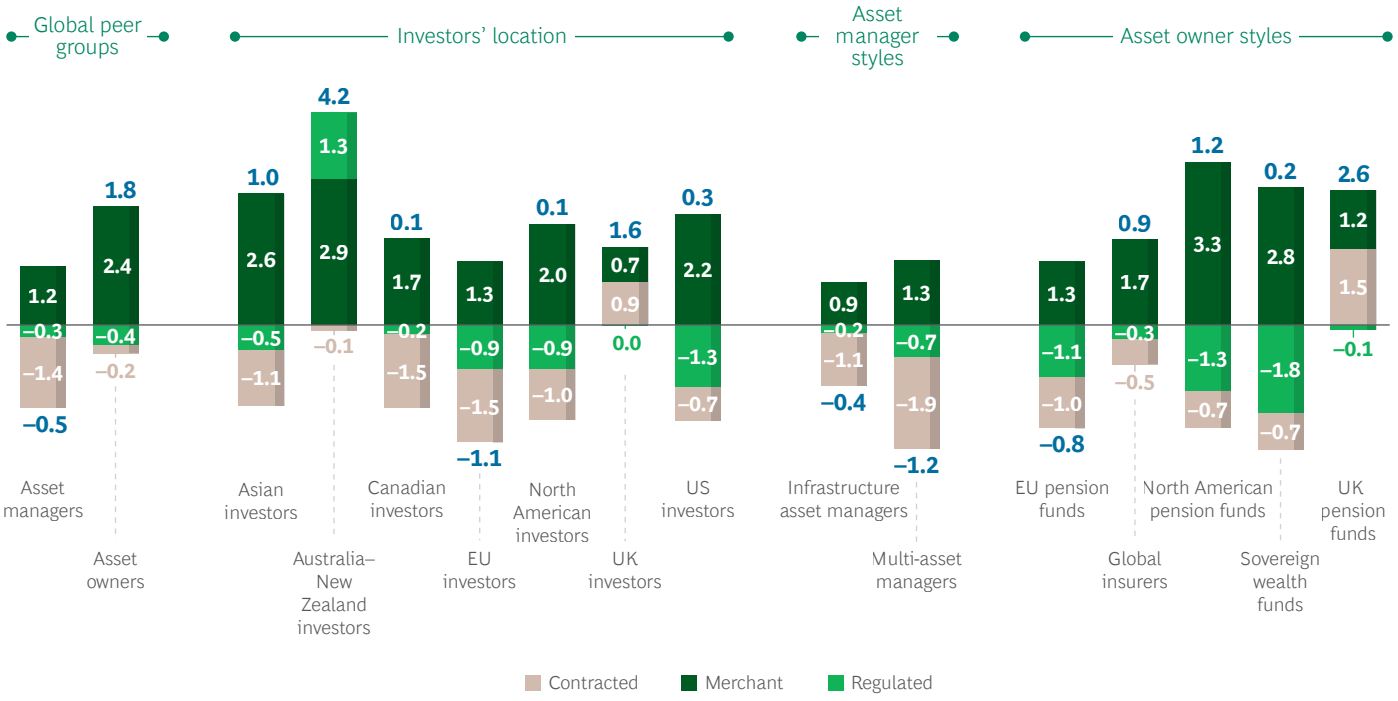


Source: EDHECinfra and BCG Survey, infraMetrics 2022.

Note: Because of rounding, not all bar segment totals add up to the figures at the tops or bottoms of bars.

Exhibit 8 - Peer Group Returns by Business Model in 2022

TICCS business model one-year total return contribution (%)

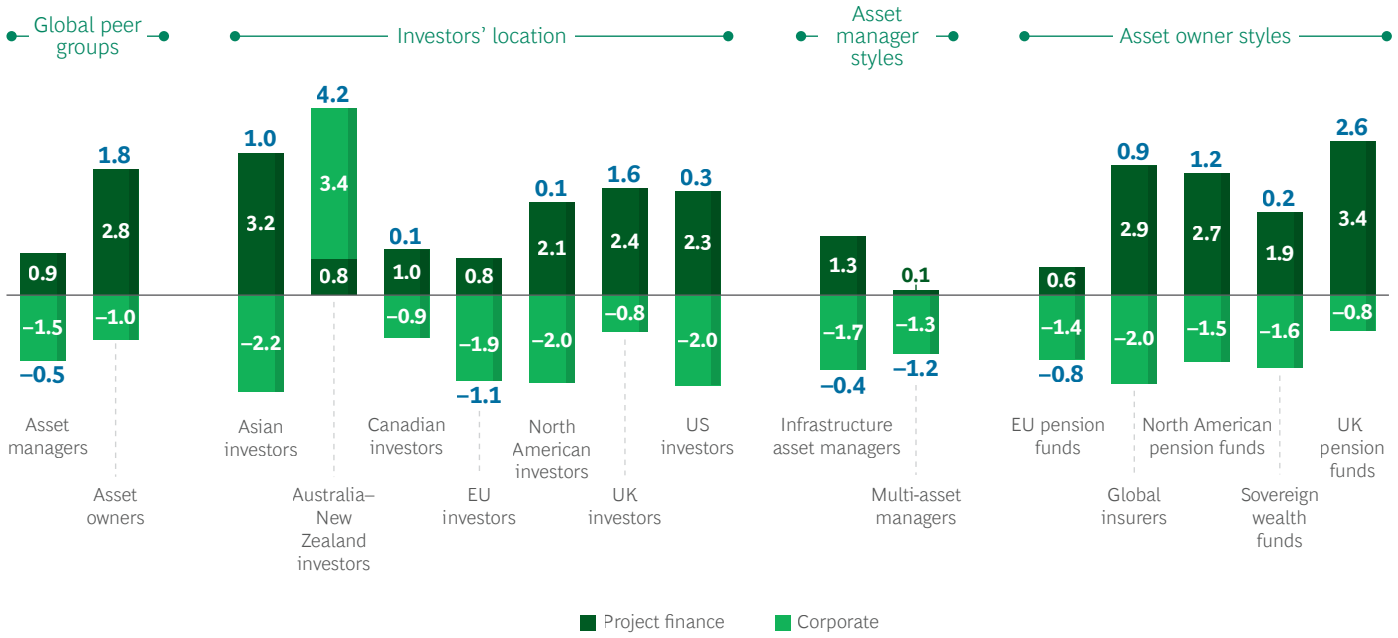


Source: EDHECinfra and BCG Survey, infraMetrics 2022.

Note: Because of rounding, not all bar segment totals add up to the figures at the tops or bottoms of bars.

Exhibit 9 - Peer Group Returns by Corporate Structure in 2022

TICCS corporate structure one-year total return contribution (%)



Source: EDHECinfra and BCG Survey, infraMetrics 2022.

Note: Because of rounding, not all bar segment totals add up to the figures at the tops or bottoms of bars.

How We Rank Infrastructure Investors

It's important to differentiate between infrastructure investors because several different kinds—including pension funds, insurance companies, specialized fund managers, and large multi-asset managers—have entered the infrastructure investments market. Because they differ in size and in strategy, ranking their performance is sort of like comparing roads and bridges.

To identify comparable groups of investors—which we term *peer groups*—we adopted the investment strategies defined by EDHECinfra's The Infrastructure Company Classification Standard (TICCS). This model captures the characteristics of investments by industry, business risk, and governance structure, and identifies various ways in which investors can gain access to investment opportunities. EDHECinfra updates the taxonomy whenever it adds new markets and companies to the database.

To create an exhaustive list of peer groups, we collected data on portfolio allocations from a survey that BCG and EDHECinfra conducted jointly in 2022. Desk-based research on the EDHECinfra database of unlisted infrastructure investments supplemented the survey data. In the case of asset owners, many of whom prefer to invest indirectly through managed funds, we accounted for both their direct and their indirect holdings. Like last year's report, this year's excludes private debt and publicly traded infrastructure investments from consideration.

Our methodology ensures that the analysis covers investors across a wide range of sizes, geographies, and investment preferences. Overall, we analyzed 681 investors and their portfolio allocations, and we identified 16 peer groups, each with a distinct investment strategy. To ensure that we had enough data to meaningfully define a strategy, we required each peer group to include at least ten investors. For our calculations, we used portfolio data as of December 31, 2022, meaning that the allocations are representative of strategies pursued over the past year. Undoubtedly, they will change in the future as the investment values and investors' objectives evolve.

In creating performance benchmarks, we started with the allocations of the Infra300 Index, which represents the entire infrastructure investments market. We rescaled the weights of the index's underlying constituents to match the strategy of each peer group, and we used infraMetrics' data on gross unlisted equity returns (in local currencies) to build its strategy-based benchmark. We treated the benchmarks as a constant for the past three years, but to get a robust estimate of volatility, we also used a ten-year standard deviation of returns (based on 120 points of data) while holding each investment strategy constant.

We ranked peer group strategies by their 2022 risk-adjusted returns, as measured by the Sharpe Ratio, which is computed using the one-year total return and the standard deviation of monthly returns over ten years. We used the average allocations to different segments to compute each group's risks, returns, and rankings. (Exhibit 4 in the main text summarizes the risk and returns across peer groups, and shows the one-year total return, the three-year total return, the volatility estimate over a ten-year period, and the one-year Sharpe Ratio calculated from the one-year return and the volatility estimate.)

Nothing is free in the market, however, and every investor bears an investment cost. For example, asset owners invest in infrastructure directly and indirectly, through managed funds, and accordingly they incur direct costs and pay management fees. As a result, their net returns differ from the returns we computed for the purpose of evaluating each group's relative performance.

To get a cost-independent view of performance across investment strategies, we used gross returns and a like-for-like measure of risk-adjusted returns, so we could rank the relative performance of all the investors in each peer group. The table in Exhibit 4 shows the contributions of the TICCS segments to the one-year total return. We computed them by adding the weight of the peer group in its meta-segment and the performance of that segment, both in basis points, to yield the group's one-year total return.

Location-Based Peer Groups

Seven peer groups' investment strategies differ by geography.

Portfolio Allocations. Asian investors, had extremely balanced allocations, with the greatest amount of investment in renewables and transport. They concentrated their investments in project-financed companies, second only to UK investors. Australia and New Zealand investors invested more than a third of their portfolios in the transport sector, the highest among geography-based groups, and exhibited the least preference for renewable power. Their portfolios were evenly split by business risk, and made the highest allocations to corporates among their peers.

As of last year, Canadian investors had allocated 12% more to social infrastructure than US investors had. Their allocations to corporate investments were second only to those of Australia–New Zealand investors, and they showed a preference for regulated pipeline companies, although not to the extent that US investors did. European investors committed close to 40% of their investments to renewable energy, and had more project-financed companies in their portfolios than did their North American counterparts.

North American (US and Canadian) investors invested a quarter of their portfolios in high-risk energy and water resource assets, such as oil and gas pipelines, and more than 50% in contracted companies. Half of UK investors' portfolios went into renewables and social infrastructure companies. As a group, UK investors appeared to be highly risk-averse, allocating less than 10% of their investments to merchant companies. Strikingly, US investors had a 37% exposure to the oil and gas sector, the highest among all 16 peer groups. Most of their investments were in contracted businesses, split equally between regulated entities and market-driven ones.

2022 Performance. Australia–New Zealand investors outranked their geographical peers, with their investments in transportation companies contributing the most to their one-year returns and proving to be the differentiating factor. Their transportation investments lost 16% of their value because of higher interest rates, but their higher merchant transport exposure benefited from the fall in equity risk premiums and increase-in-revenue forecasts.

UK investors ranked second, an improvement over their last-place position in 2021, although they still trailed the other groups over the three-year period from 2019 to 2022. In contrast, Asian investors, who ranked third in this group, drove most of their returns from merchant investments and were the group least impacted by changes in interest rates in 2022. US investors ranked fourth, reaping limited rewards from their higher-than-average oil and gas exposures, while North American investors ranked fifth, mainly because of their lower merchant exposures. Canadian investors ranked sixth in 2022, despite generating balanced returns across industries, and European investors ranked last in this category.

Asset Manager Strategy Group

This group consists of smaller specialized infrastructure asset managers and larger multi-asset managers.

Portfolio Allocation. Roughly 50% of the smaller specialized managers' investments were in renewables and transportation, with three-fourths allocated to project-financed companies. Although multi-asset managers' investments were similar to those of specialized infrastructure asset managers, they showed a slightly stronger bias in favor of energy and water resource assets. They also invested 8% more than specialist managers did in regulated companies and 12% more in private sector infrastructure companies.

2022 Performance. Specialized infrastructure managers delivered better returns than multi-asset managers did in 2022, but they trailed over the longer three-year term. The two groups' returns were similar by industry, but the specialists' lower merchant investments and lower exposure to regulated entities gave them an edge. The specialists were also less affected by rising interest rates, thanks to their higher allocations to contracted project-financed companies, while multi-asset managers' cashflow projections outperformed the specialists'.

Asset Owner Strategy Groups

This category consists of groups of institutional investors, such as insurers and pension funds, whose investment choices differ from those of other investors.

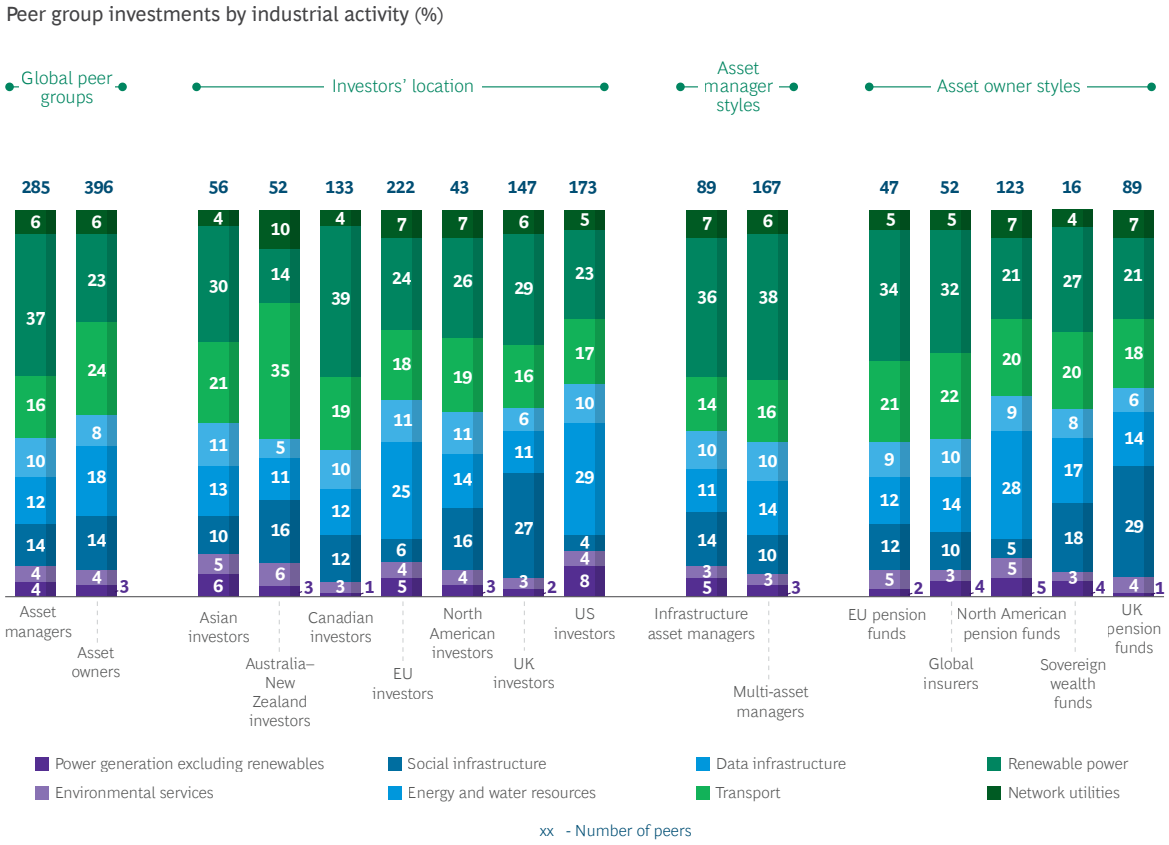
Portfolio Allocations. EU pension funds had much of their portfolios in renewable energy and transportation, and the highest preference for regulated business in this group, with an allocation of almost 40%. Global insurers made the largest allocations to data infrastructure among all the groups, and dedicated over three-fourths of their portfolios to project-financed companies, second only to UK pension funds.

North American pension funds had the highest allocation to pipeline companies and the least to social infrastructure. They had little exposure to regulated businesses, as more than 80% of their allocations were in contracted and market-based entities. Sovereign wealth funds' portfolio allocations were balanced by industry, with a relatively high allocation of 18% to social infrastructure. At 43%, they also had one of the lowest exposures to contracted businesses. UK pension funds' 29% allocation to social infrastructure was the highest among all the peer groups. Their highly conservative investment strategies were reflected in their 78% allocation to contracted businesses and their 94% exposure to project-financed companies last year.

2022 Performance. UK pension funds topped the group of asset owners, driven by their investments in social infrastructure and transport companies. Ranking second were North American pension funds, which benefited from the higher valuations of their merchant investments on account of lower equity risk premiums. In this group, global insurers ranked third, with returns coming from project-financed companies in the transport sector. They were the least affected by the interest rate increases, and their cashflow projections rose by 1.5%.

Sovereign wealth funds suffered from their contracted and regulated investments, however, which drove them down to fourth place. Bringing up the rear were the EU pension funds, whose one-year returns entered negative territory. That was mainly because of the performance of their contracted investments, which witnessed a loss in earnings because of falling margins in the transportation sector. (See Exhibits 10, 11, and 12 for a detailed look at the peer groups' performance in 2022 by industry, business model, and corporate structure.)

Exhibit 10 - Peer Group Investments by Industry in 2022

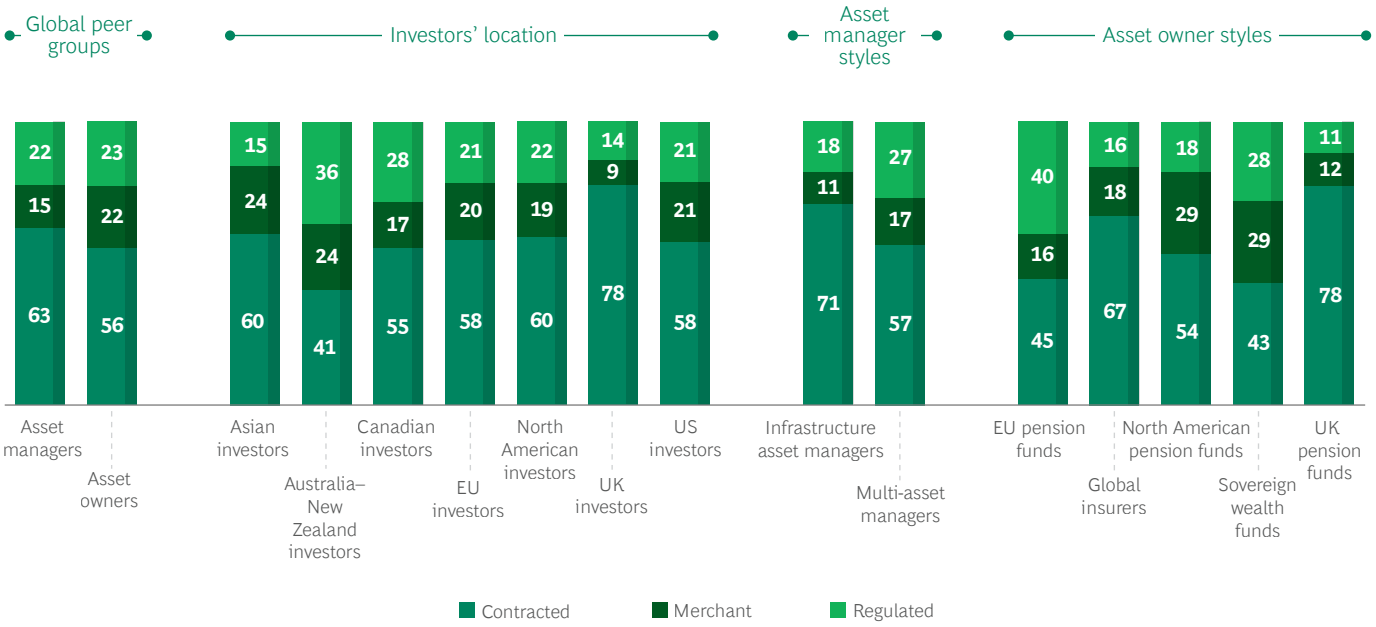


Source: EDHECinfra and BCG survey, infraMetrics 2022.

Note: North America investors consist of US and Canadian investors. Because of rounding, not all bar segment totals add up to 100%.

Exhibit 11 - Peer Group Investments by Business Model in 2022

Peer group investments by type of business model (%)

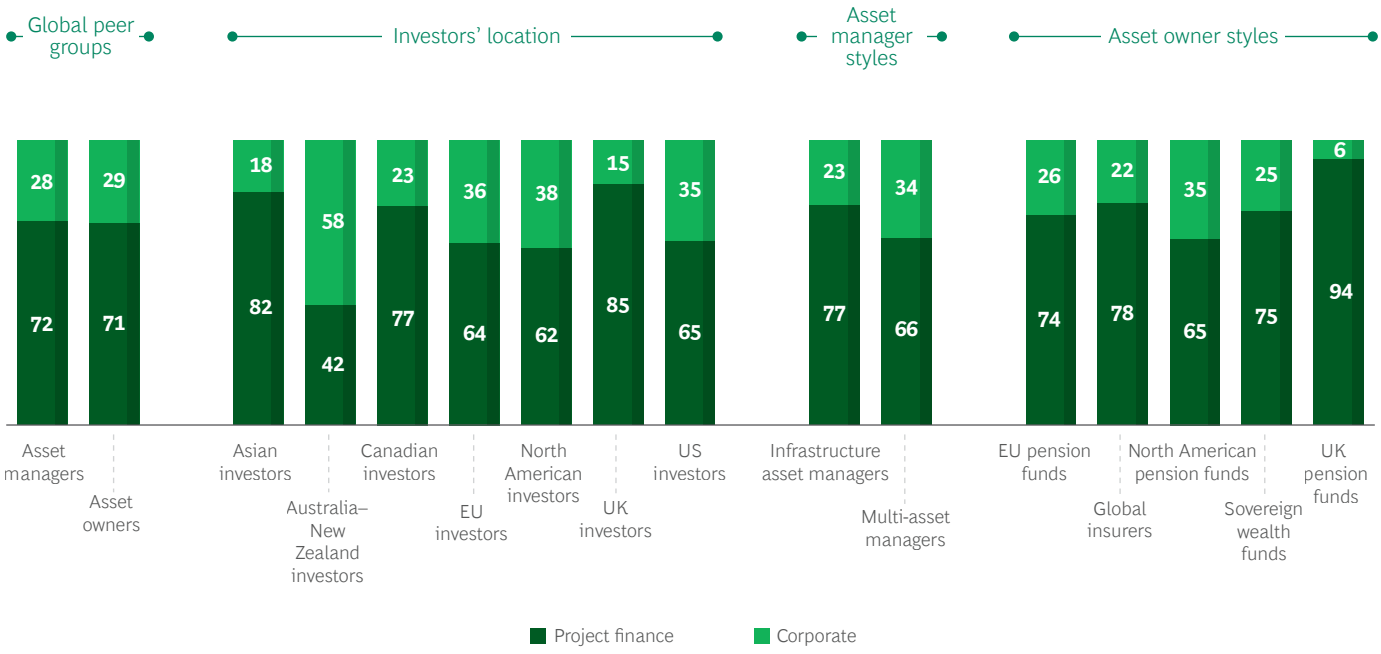


Source: EDHECinfra and BCG survey, infraMetrics 2022.

Note: Because of rounding, not all bar segment totals add up to 100%.

Exhibit 12 - Peer Group Investments by Corporate Structure in 2022

Peer group investments by type of corporate structure (%)



Source: EDHECinfra and BCG survey, infraMetrics 2022.

The three-year value decomposition study that we referred to earlier shows one common trend among the peer groups from 2019 to 2022. Asset owners in the global peer group and Australia–New Zealand investors in the location-based group experienced higher value creation in their investments because of the growth of price-earnings multiples, which increased by a remarkable 19%. Similarly, the price-earnings multiples of asset managers' allocations grew by almost 10% over the past three years, which is why they saw more value creation than the infrastructure specialists did. Only the asset owner style funds' performance differed. North American pension funds, the leaders in this group, were buoyed mainly by the increase in profit margins in their oil and gas investments during the past three years.

The 2022 Infrastructure Investors' Leaderboard differs considerably from the previous year's, mainly because of investors' portfolio allocations and the infrastructure market's performance. Most investors had substantial stakes in contracted and project-financed infrastructure companies, which accounted for over 70% of portfolios in 10 of the 16 peer groups. Investors' allocations to digital infrastructure rose, too, as we anticipated in last year's report, and constituted from 8% to 10% of most peer groups' portfolios, except for those of UK and Australia–New Zealand investors.

Transport and power-generation companies, excluding those in renewable energy, performed better in 2022 than they did during the previous year, so peer groups with higher exposures to those two segments generated higher returns. Although the infrastructure market is usually associated with cash payouts, some market segments offered an opportunity for value creation last year. Indeed, 2022 provided unmistakable evidence of the resilience that infrastructure investments display in the face of global economic uncertainty. And resilience drives returns despite risks.

Investment Strategies for the Hydrogen Age

Although it's the most abundant element in the universe, hydrogen could prove to be an interesting alternative investment for infrastructure investors. That was BCG's conclusion after we went beyond the hype on hydrogen to shine a spotlight on the emerging opportunities in the hydrogen industry.

Low-carbon hydrogen, we find, will be a $6 trillion to $12 trillion investment opportunity over the next three decades leading up to 2050. Because the hydrogen industry is evolving slowly, however, infrastructure investors must fashion creative strategies if they wish to capture an early-mover advantage in this industry. (See Exhibit 13.)

Fueling the Future

Hydrogen is attracting attention because, as the world's economies strive to grow more sustainably, an energy transition has begun. The 2015 Paris Agreement on Climate Change set a limit on global warming of less than 2°C—and, ideally, less than 1.5°C—compared to preindustrial levels. To meet that goal, carbon emissions must drop by 45% from today's levels by 2030, and then reach net zero by 2050, when the world's nations have promised to decarbonize the planet.

As the world decarbonizes, novel options such as low-carbon hydrogen are coming into their own. Whereas companies generate gray hydrogen from natural gas or methane, low-carbon hydrogen is produced through electrolysis powered by renewable energy sources such as wind or solar (green hydrogen) or fossil fuels paired with carbon capture and storage (blue hydrogen). Low-carbon hydrogen will play a key role in the decarbonization of several industries with hard-to-abate emissions, such as basic chemicals, aviation, steel production, shipping, and long-haul road transportation.

To meet the world's decarbonization goals, the public and private sectors must invest from $6 trillion to $12 trillion by 2050 in assets to produce and transport low-carbon hydrogen, according to BCG's calculations. Demand for hydrogen in 2021 amounted to 94 million tons—around 99% of it in the form of gray hydrogen—but demand for low-carbon hydrogen is projected to be approximately 350 million tons per annum (mtpa) by 2050 in the 2°C warming scenario and as much as 530 mtpa in the 1.5°C scenario. Hence the need for $6 trillion to $12 trillion in capital expenditure from 2025 to 2050.

Government policies will encourage adoption of low-carbon hydrogen as a fuel source. For instance, under the Repower EU policy framework, the EU has set a target of producing and consuming 20 mtpa of green hydrogen by 2030. Meanwhile, recent US policy changes have altered the economics of low-carbon hydrogen. The Infrastructure Investment and Jobs Act of 2021 provided for around $10 billion in incentives for hydrogen hubs, and the Inflation Reduction Act of 2022 included another $8 billion in incentives.

Even so, governments and corporate balance sheets can't fund all the investments needed for low-carbon hydrogen. Low-cost sources of capital, such as infrastructure investors, will play a critical role in providing debt and inexpensive equity for hydrogen projects in the future. Indeed, low-carbon hydrogen generation is a logical extension for infrastructure funds with a mandate to develop sustainable resources.

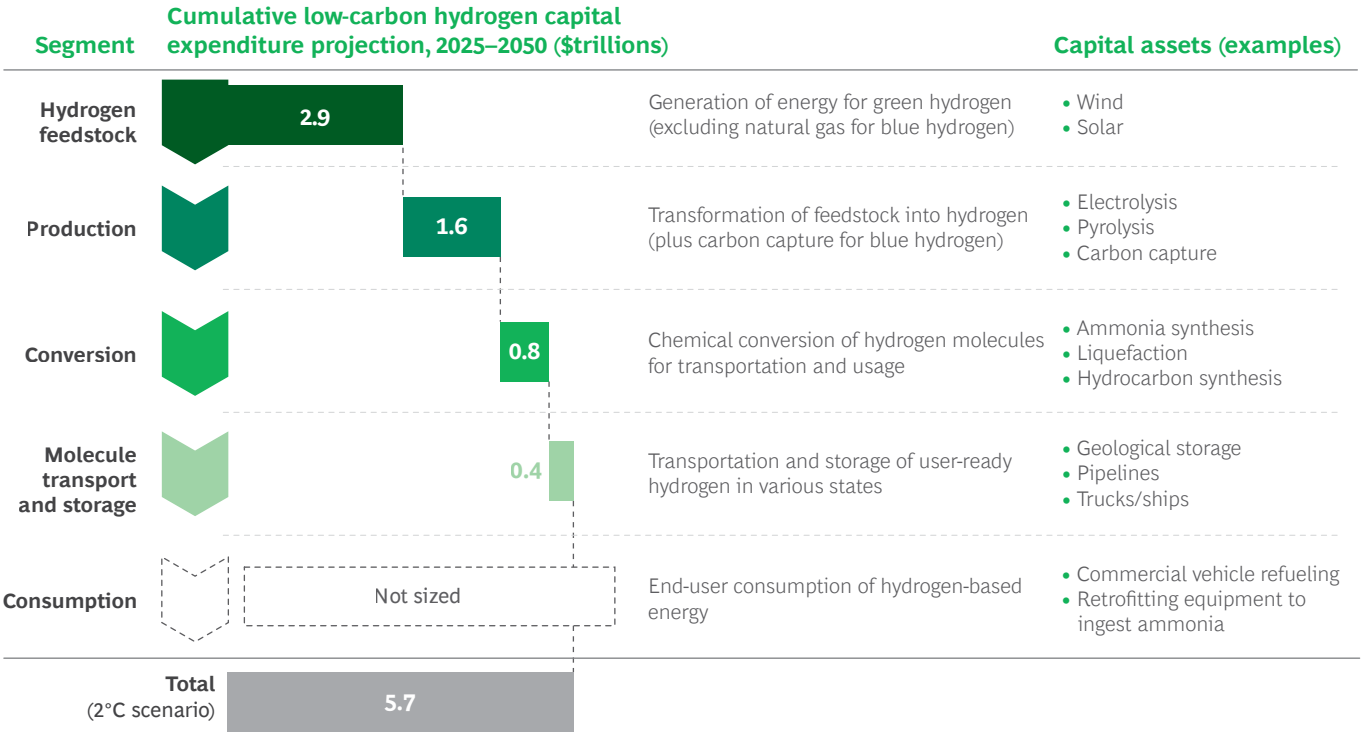
Dealing with the Investment Dynamics

The potential of low-carbon hydrogen may be enormous, but the industry is young, and its structure is emergent. The current dynamic in the industry shares some characteristics with renewable energy sectors such as solar power and wind energy in the early 2000s. Then, although companies drafted plans for many projects in those industries, few projects reached the final investment decision stage, leading to uncertainty about which technologies and applications would be long-term winners.

The Short-Run Challenge. Low-carbon hydrogen production and transportation check all the boxes of a classic infrastructure investment: they are essential, inflation-linked services with meaningful barriers to entry and are backed by capital assets. Nevertheless, there is a mismatch between investors' expectations and the risk profiles of current opportunities.

Most investors aren't willing to invest in projects that have high technology or project risks and commercial or offtake risks. (See Exhibit 14.) So financing for most low-carbon hydrogen projects has come from the world's oil and natural gas majors; industrial gas companies driven by voluntary decarbonization initiatives; and some utilities with hydrogen-related ambitions.

Exhibit 13 - The Hydrogen Industry's Need for Capital Between 2025 and 2050



Source: BCG analysis.

Note: These projections don't include the grid infrastructure required for green energy generation that is not colocated with electrolysis.

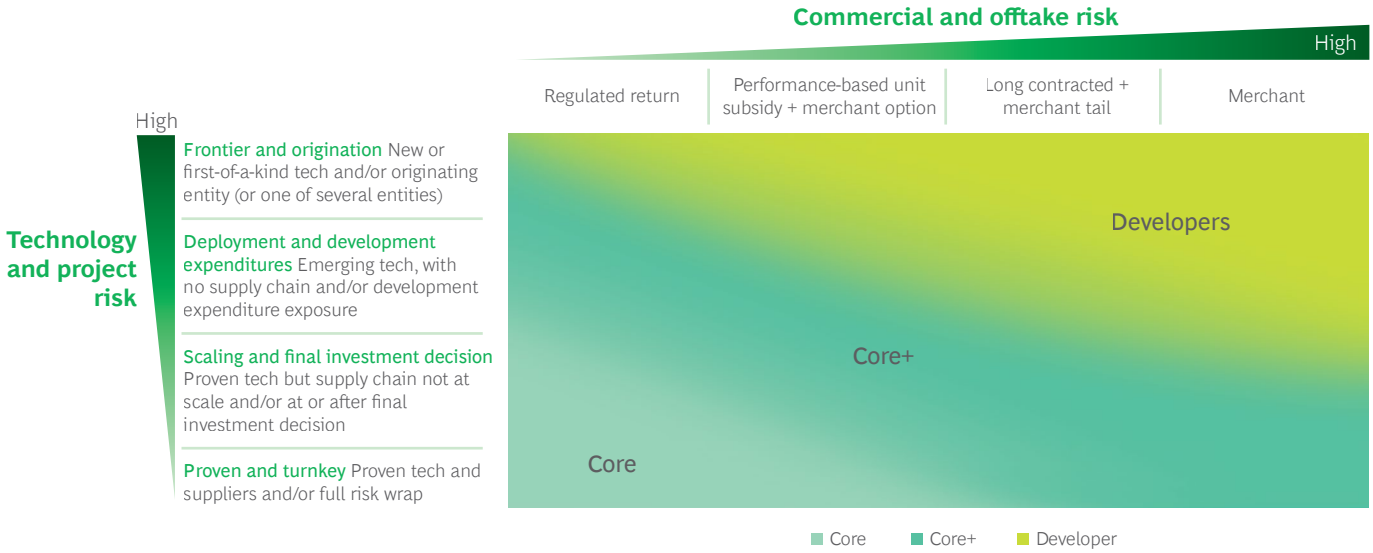
Even when long-term hydrogen offtake agreements exist, investors must take into account natural gas, carbon, and power prices and subsidies, both to anticipate price-opportunistic profit taking and to understand low-carbon hydrogen sellers' costs, while evaluating their future cashflows. Moreover, because a global hydrogen supply chain isn't in place yet, most hydrogen production facilities have been located or are planned to be built near valleys of consumption.

Business must overcome numerous bottlenecks to develop a hydrogen supply chain, especially since its transport is complicated and expensive. Promising technologies, such as cracking ammonia or using liquid organic hydrogen carriers—organic compounds that can absorb and release hydrogen through chemical reactions—are still being developed. Meanwhile, supply chains for hydrogen derivatives, such as those for the export of green ammonia, are emerging.

The Medium- to Long-Run Opportunity. Eventually, opportunities in the hydrogen industry that appeal to infrastructure investors with a range of risk and return appetites are bound to arise. Those opportunities will extend along the entire hydrogen value chain, from feedstock development and generation to hydrogen transportation and storage. From $300 billion (in the 2°C scenario) to $700 billion (in the 1.5°C scenario) must be deployed soon, from 2025 to 2030.

The need for capital at each link in the value chain will vary by geography, as different countries will pursue different hydrogen strategies. For instance, the US is trying to become self-sufficient in manufacturing low-carbon hydrogen, and it envisions a more vital role for blue hydrogen than does, say, Europe, which plans to rely more heavily on green hydrogen. As a result, the US will need to direct more investment toward creating green energy generation and carbon capture, utilization, and storage assets, while the EU will have more need for capital to build hydrogen transportation infrastructure such as pipelines and storage tanks.

Exhibit 14 - Infrastructure Investors Don't Take On Project or Commercial Risks



Source: BCG analysis.

Regional economic policy will also influence the avenues open to infrastructure investors. Europe's plan to expand its unbundling framework to pipeline regulation, for example, will create investment opportunities for new players. Existing owners of upstream production facilities in Europe won't be allowed to own controlling stakes in hydrogen pipelines. The US doesn't plan to adopt this approach, so incumbent industrial gas players such as Air Products, Air Liquide, and Linde and regional players such as Messer and Matheson are likely to play a central role in creating the US's hydrogen pipeline infrastructure.

Four Investment Strategies for the Future

Historically, early investors have generated higher returns by being the first to move into infrastructure sectors. That has been especially true in the renewable energy industry: firms that invested in wind energy and solar power generation in the early 2010s reported higher internal rates of return than those that did so in the following decade.

The benefits aren't just financial. Early investors gain three additional advantages. First, investing in ventures during the initial stages of a sector's development allows firms to learn how to manage risks as the segment and the players scale and mature. Second, investors can capture scarce resources, such as talent, for the companies they invest in, and can build relationships across the value chain. Third, early movers gain visibility, resulting in preferential access to promising investment opportunities as they emerge.

For all of these reasons, infrastructure investors would do well to design innovative strategies that help them gain early-mover advantages in the emergent hydrogen industry. Four strategies, in particular, may help some investors outperform others: follow the subsidies, shift the risks, create a portfolio, and expand your risk appetite.

Follow the subsidies. One option is to invest only in countries and segments of the value chain where policy-makers have developed or plan to create monetary mechanisms that will limit their risks. These incentives may take the form of governments matching investments by business in hydrogen projects; direct tax incentives; or contracts for difference, in which governments agree to a fixed price for low-carbon and green hydrogen and subsidize the difference between that (higher) price and the (lower) price of gray hydrogen.

Infrastructure investors in the US, for instance, could follow the Biden Administration's cues. The recently enacted IIJA provides $8 billion for creating regional low-carbon hydrogen hubs, $1 billion for an electrolysis program to reduce hydrogen production costs, and $500 million each for creating hydrogen-manufacturing and hydrogen-recycling equipment supply chains. Likewise, the IRA has made other incentives available, offering a hydrogen production tax credit of up to $3 per kilogram for green hydrogen and 20 cents to 80 cents per kilogram for blue hydrogen, and expanding the investment tax credit to cover hydrogen manufacturing and storage technology projects. Those incentives are bound to attract more investors to the sector.

Shift the risks. Smart investors may decide to invest in low-carbon projects—which can be complex, investment-heavy, and time-consuming—after shifting some of the execution risks to seasoned partners. After securing a commercial agreement for a hydrogen-related asset, for example, infrastructure investors might set up a special-purpose vehicle in partnership with an engineering, procurement, and construction company willing to provide a comprehensive risk wrap. Under this arrangement, the investor assumes the financing risks but transfers the technical risks to the engineering firm. Similar deal structures have been used in the carbon capture, carbon utilization, carbon storage, and wind energy industries.

Create a portfolio. Some infrastructure investors may want to invest in various hydrogen-related projects to generate synergies that will help each one perform better. This could be done in several ways. First, investors could try to generate synergies between demand- and supply-side hydrogen assets—for example, by investing in the ownership of assets that produce low-carbon ammonia and assets that consume it.

Second, infrastructure investors could use their investments to pool demand for hydrogen and thus minimize supply-side risks. For instance, an infrastructure investor could channel the supply of low-carbon hydrogen from companies that it has invested in to a transnational corporation that operates in two or more regions. Doing so would help the investor benefit from investment opportunities in the adjacent infrastructure, whether in the form of new assets, such as new hydrogen handling facilities at ports, or additions to existing assets, such as retrofitting pipelines to carry hydrogen.

Expand your risk appetite. Yet another strategy that infrastructure investors can adopt is to expand their risk tolerance to gain early momentum. They could take on additional risk by increasing their involvement during the project development phase. They could even make investments before the final investment decision—when the company planning the project approves its development—occurs. Similarly, infrastructure investors could broaden the financial instruments they use to include, for instance, convertible debt.

Many infrastructure investors will be tempted to expand the geographic scope of their investments. Low-carbon hydrogen valleys are emerging in noncore infrastructure investment markets such as Africa and South America, and will need capital to scale.

Other infrastructure investors could evaluate entirely new kinds of assets. For instance, they might invest in equipment manufacturers. In the renewable energy industry, infrastructure investors have usually taken ownership stakes in operating assets, while private equity investors have invested in equipment and services. In addition to being attractive standalone investments, equipment OEMs can be appealing as avenues to more traditional capital asset investments—for example, by offering a way to secure preferential access in the supply-constrained electrolyzers market.

Investors can also find ways to de-risk their hydrogen investments, although the industry is young and lacks scale. Smart investors will focus on understanding and investing in particular areas of the business. Doing so could prove to be critical. The hydrogen business has three layers of complexity—technological, political, and commercial—that investors must come to grips with. In the process, pioneering investors could evolve beyond being capital providers to mapping the major players and investing in building networks to create new opportunities. Becoming ecosystem enablers can optimize investors' returns from the hydrogen industry.

By focusing on specific links in the chain, investors can increase the value added from existing capabilities such as technical expertise, government relationships, suppliers access, and links with would-be customers. They can co-invest in hydrogen projects with energy companies, building consortia to de-risk investments. These consortia will count different kinds of customers among their members, thus reducing a hydrogen company's exposure to a single market. Forming a consortium will also help attract public funding, which will lower infrastructure investors' risks.

Starting Out in Sustainable Hydrogen

The medium- and long-term investment opportunities in low-carbon hydrogen may be compelling, but identifying how infrastructure investors should test the waters isn't easy. Our studies suggest three immediate strategies for investors that wish to adopt a thematic approach and focus on long-term trends rather than on specific companies:

- **Spot diamonds in the rough.** This strategy involves identifying low-carbon hydrogen assets whose bottom lines will receive a boost in the future because of newly enacted government policies and subsidies or technological changes. In the US, the IRA's newly-announced subsidy of $3 per kilogram for green hydrogen will improve energy assets' financial returns. For example, wind farms could increase their profitability by using electrolyzers that consume the electricity generated during off-peak hours to produce hydrogen rather than dispatching power to the grid at times when demand and prices are low.

- **Find newly greening companies.** Midstream oil and gas assets that can retrofit to transport hydrogen will become more attractive in coming years. Investors could also take positions in steel manufacturing plants that are switching to the direct reduced iron process, building plants that run almost entirely on low-carbon hydrogen or that blend the feed gas with low-carbon hydrogen from electrolyzers powered by renewable electricity.

- **Target chokepoints.** Investing in asset creation at links in the hydrogen value chain where capacity is nonexistent, or insufficient, positions the investor in a place of need. For example, gas distribution companies will have to build tanks, storage facilities, and handling terminals at ports to benefit from hydrogen transportation. They will also have to invest in infrastructure for carrying ammonia, which will increasingly serve as a medium for storing hydrogen, and is usually transported as a pressurized liquefied gas in railway cars, tanker trucks, and pipelines.

Hydrogen has long been regarded as a key part of the quest to create a sustainable planet. But even as wind and solar power became popular in recent years, several challenges hindered plans for developing hydrogen power. That has changed, with more countries establishing national hydrogen strategies, providing fresh impetus to the industry, and paving the way for investments in the sector. Hydrogen may finally be poised to have its moment in the sun, which should draw infrastructure investors to this sector.

Appendix

The Infrastructure Company Classification Standard (TICCS)

As private infrastructure investment emerged as a global asset class, it raised the need for a classification system for infrastructure companies that equity investors could acquire and debt investors could lend to. In 2018, EDHECinfra created The Infrastructure Company Classification Standard (TICCS) to give investors a frame of reference to use in approaching the infrastructure asset class.

TICCS is designed to be compatible with other standard investment-classification schemes, but it also uses insights from academic literature to create a classification that embodies key aspects of infrastructure businesses' risk profiles. As new markets and companies come into the EDHECinfra database, the infrastructure investment industry reviews it regularly. It is also the object of an annual market consultation and is audited by an independent review committee that includes senior representatives of the standard-setting and infrastructure investment industry.

The peer groups in BCG's 2023 Infrastructure Report are based on the TICCS classification, which captures the characteristics of infrastructure investments by industry, business risk, and corporate governance structure. (See Appendix Tables 1 through 6.)

Ultimately, any infrastructure investment corresponds to shares (or quasi-equity) invested in a company or to debt instruments issued by a company (or borrower). The TICCS taxonomy is designed to classify and organize data about equity and debt investments in infrastructure companies. Its class-based taxonomy consists of four pillars:

- Business risk classification (BR)
- Industrial classification (IC)
- Geo-economic classification (GE)
- Corporate governance classification (CG)

Each pillar consists of nonoverlapping superclasses, classes, and subclasses of characteristics. Infrastructure investment companies belong to each individual pillar and may also fall into multiple classes within each pillar. For instance, an infrastructure company may own both a water treatment plant and a power generation asset. (For further details about TICCS, see The Infrastructure Classification Standard (TICCS™) (PDF download).

TICCS also takes risk into account. However, it is not designed to differentiate between sources of systematic risks in infrastructure companies. Rather, as a taxonomy of infrastructure companies, TICCS aims to supply an exhaustive list of objective, real-world, distinguishing characteristics; that is, it is a system designed to organize information about infrastructure investment firms.

Each TICCS pillar captures a different dimension of what makes infrastructure investment firms both unique and relatively homogeneous. In that sense, TICCS pillars capture differences in aggregate risk profile that reflect combinations of systematic risk factors, even though the latter are not the object of the taxonomy.

Appendix Table 1 - Peer Group Returns in 2022 by Industry

Peer group	Number of peers	Power generation excluding renewables (%)	Environmental services (%)	Social infrastructure (%)	Energy and water resources (%)	Data infrastructure (%)	Transport (%)	Renewable power (%)	Network utilities (%)
TICCS code		IC10	IC20	IC30	IC40	IC50	IC60	IC70	IC80
Global peer groups									
Asset managers	285	4.0	4.0	11.0	12.0	10.0	16.0	37.0	6.0
Asset owners	396	3.0	4.0	14.0	18.0	8.0	24.0	23.0	6.0
Investors' location									
Asian investors	56	6.0	5.0	10.0	13.0	11.0	21.0	30.0	4.0
Australia–New Zealand investors	52	3.0	6.0	16.0	11.0	5.0	35.0	14.0	10.0
EU investors	133	1.0	3.0	12.0	12.0	10.0	19.0	39.0	4.0
North American investors	222	5.0	4.0	6.0	25.0	11.0	18.0	24.0	7.0
Canadian investors	43	3.0	4.0	16.0	14.0	11.0	19.0	26.0	7.0
UK investors	147	2.0	3.0	27.0	11.0	6.0	16.0	29.0	6.0
US investors	173	8.0	4.0	4.0	29.0	10.0	17.0	23.0	5.0
Asset manager styles									
Infrastructure asset managers	89	5.0	3.0	14.0	11.0	10.0	14.0	36.0	7.0
Multi-asset managers	167	3.0	3.0	10.0	14.0	10.0	16.0	38.0	6.0
Asset owner styles									
EU pension funds	47	2.0	5.0	12.0	12.0	9.0	21.0	34.0	5.0
Global insurers	52	4.0	3.0	10.0	14.0	10.0	22.0	32.0	5.0
North American pension funds	123	5.0	5.0	5.0	28.0	9.0	20.0	21.0	7.0
Sovereign wealth funds	16	4.0	2.5	18.0	16.6	7.6	20.0	27.0	4.0
UK pension funds	89	1.0	4.0	29.0	14.0	6.0	18.0	21.0	7.0

Source: BCG and EDHECinfra analysis.

Note: IC = industrial classification.

Appendix Table 2 - Peer Group Portfolio Allocations in 2022 by Risk

Peer group	Number of peers	Contracted (%)	Merchant (%)	Regulated (%)
TICCS code		BR10	BR20	BR30
Global peer groups				
Asset managers	285	62.6	15.3	22.1
Asset owners	396	55.7	21.7	22.7
Investors' location				
Asian investors	56	60.4	24.3	15.3
Australia–New Zealand investors	52	40.6	23.5	35.9
EU investors	133	55.4	16.5	28.1
North American investors	222	58.3	20.4	21.3
Canadian investors	43	59.5	18.9	21.6
UK investors	147	77.9	8.6	13.5
US investors	173	57.6	21.2	21.2
Asset manager styles				
Infrastructure asset managers	89	71.2	11.0	17.9
Multi-asset managers	167	56.5	16.9	26.6
Asset owner styles				
EU pension funds	47	44.7	15.7	39.6
Global insurers	52	66.8	17.5	15.7
North American pension funds	123	53.5	28.9	17.6
Sovereign wealth funds	16	43.3	29.0	27.7
UK pension funds	89	77.6	11.5	10.9

Source: BCG and EDHECinfra analysis.

Note: BR = business risk.

Appendix Table 3 - Peer Group Portfolio Allocations in 2022 by Corporate Governance

Peer group	Number of peers	Project finance (%)	Corporate (%)
TICCS code		CG10	CG20
Global peer groups			
Asset managers	285	71.8	28.2
Asset owners	396	71.1	28.9
Investors' location			
Asian investors	56	82.0	18.0
Australia–New Zealand investors	52	42.2	57.8
EU investors	133	76.9	23.1
North American investors	222	63.9	36.1
Canadian investors	43	62.4	37.6
UK investors	147	84.8	15.2
US investors	173	64.8	35.2
Asset manager styles			
Infrastructure asset managers	89	77.3	22.7
Multi-asset managers	167	65.9	34.1
Asset owner styles			
EU pension funds	47	73.7	26.3
Global insurers	52	78.1	21.9
North American pension funds	123	65.3	34.7
Sovereign wealth funds	16	75.1	24.9
UK pension funds	89	93.5	6.5

Source: BCG and EDHECinfra analysis.

Note: CG = corporate governance.

Appendix Table 4 - Peer Group One-Year Total Return Contribution in 2022 by Industry Group Style

Peer group	Power generation excluding renewables (%)	Environmental services (%)	Social infrastructure (%)	Energy and water resources (%)	Data infrastructure (%)	Transport (%)	Renewable power (%)	Network utilities (%)	Total one-year return (%)
TICCS code	IC10	IC20	IC30	IC40	IC50	IC60	IC70	IC80	
Global peer groups									
Asset managers	0.48	0.05	0.29	–0.27	–2.28	3.04	–1.73	–0.10	–0.51
Asset owners	0.46	0.04	0.35	–0.30	–1.84	4.43	–1.22	–0.12	1.81
Investors' location									
Asian investors	0.78	0.08	0.26	0.21	–2.55	3.95	–1.47	–0.23	1.02
Australia–New Zealand investors	0.32	0.08	0.36	–0.96	–1.13	6.06	–0.89	0.33	4.16
Canadian investors	0.41	0.05	0.41	–0.33	–2.61	3.36	–1.22	0.00	0.07
EU investors	0.10	0.02	0.31	–0.38	–2.33	3.66	–2.36	–0.12	–1.09
North American investors	0.62	0.05	0.16	– 0.23	–2.56	3.25	–1.07	–0.09	0.12
UK investors	0.23	0.03	0.72	0.20	–1.32	3.20	–1.23	–0.26	1.56
US investors	0.93	0.05	0.10	–0.30	–2.31	3.09	–1.06	–0.20	0.30
Asset manager styles									
Infrastructure asset managers	0.48	0.03	0.38	0.03	–2.33	2.76	–1.60	–0.13	–0.37
Multi-asset managers	0.40	0.02	0.26	–0.55	–2.33	2.93	–1.94	0.00	–1.20
Asset owner styles									
EU pension funds	0.20	0.06	0.31	–0.73	–2.09	4.19	–2.71	–0.05	–0.81
Global insurers	0.41	0.03	0.27	0.03	–2.30	4.18	–1.38	–0.29	0.92
North American pension funds	0.80	0.07	0.13	–0.16	–2.10	3.52	–0.90	–0.13	1.22
Sovereign wealth funds	0.62	0.00	0.45	–0.71	–1.76	3.65	–1.89	–0.13	0.24
UK pension funds	0.12	0.05	0.76	0.74	–1.12	3.61	–0.94	–0.61	2.61

Source: BCG and EDHECinfra analysis.

Note: 1% change = 100 basis points change; IC = industrial classification.

Appendix Table 5 - Peer Group One-Year Total Return Contribution in 2022 by Business Risk Style

Peer group	Contracted (%)	Merchant (%)	Regulated (%)	Total one-year return (%)
TICCS code	BR10	BR20	BR30	
Global peer groups				
Asset managers	–1.42	1.17	–0.25	–0.51
Asset owners	–0.17	2.38	–0.40	1.81
Investors' location				
Asian investors	–1.12	2.64	–0.50	1.02
Australia–New Zealand investors	–0.11	2.94	1.33	4.16
Canadian investors	–1.47	1.74	–0.20	0.07
EU investors	–1.46	1.27	–0.90	–1.09
North American investors	–1.01	2.03	–0.90	0.12
UK investors	0.87	0.70	–0.01	1.56
US investors	–0.67	2.23	–1.25	0.30
Asset manager styles				
Infrastructure asset managers	–1.06	0.86	–0.17	–0.37
Multi-asset managers	–1.85	1.30	–0.65	–1.20
Asset owner styles				
EU pension funds	–1.02	1.27	–1.06	–0.81
Global insurers	–0.51	1.72	–0.28	0.92
North American pension funds	–0.74	3.28	–1.33	1.22
Sovereign wealth funds	–0.74	2.76	–1.78	0.24
UK pension funds	1.54	1.17	–0.09	2.62

Source: BCG and EDHECinfra analysis.

Note: 1% change = 100 basis points change; BR = business risk.

Appendix Table 6 - Peer Group One-Year Total Return Contribution in 2022 by Corporate Governance Style

Peer group	Project finance (%)	Corporate (%)	Total one-year return (%)
TICCS code	CG10	CG20	
Global peer groups			
Asset managers	0.94	–1.45	–0.51
Asset owners	2.81	–0.99	1.81
Investors' location			
Asian investors	3.17	–2.15	1.02
Australia–New Zealand investors	0.81	3.35	4.16
Canadian investors	1.01	–0.94	0.07
EU investors	0.81	–1.90	–1.09
North American investors	2.07	–1.95	0.12
UK investors	2.38	–0.82	1.56
US investors	2.31	–2.01	0.30
Asset manager styles			
Infrastructure asset managers	1.30	–1.67	–0.37
Multi-asset managers	0.11	–1.31	–1.20
Asset owner styles			
EU pension funds	0.62	–1.43	–0.81
Global insurers	2.89	–1.97	0.92
North American pension funds	2.71	–1.49	1.22
Sovereign wealth funds	1.85	–1.61	0.24
UK pension funds	3.42	–0.80	2.62

Source: BCG and EDHECinfra analysis.

Note: 1% change = 100 basis points change; CG = corporate governance.

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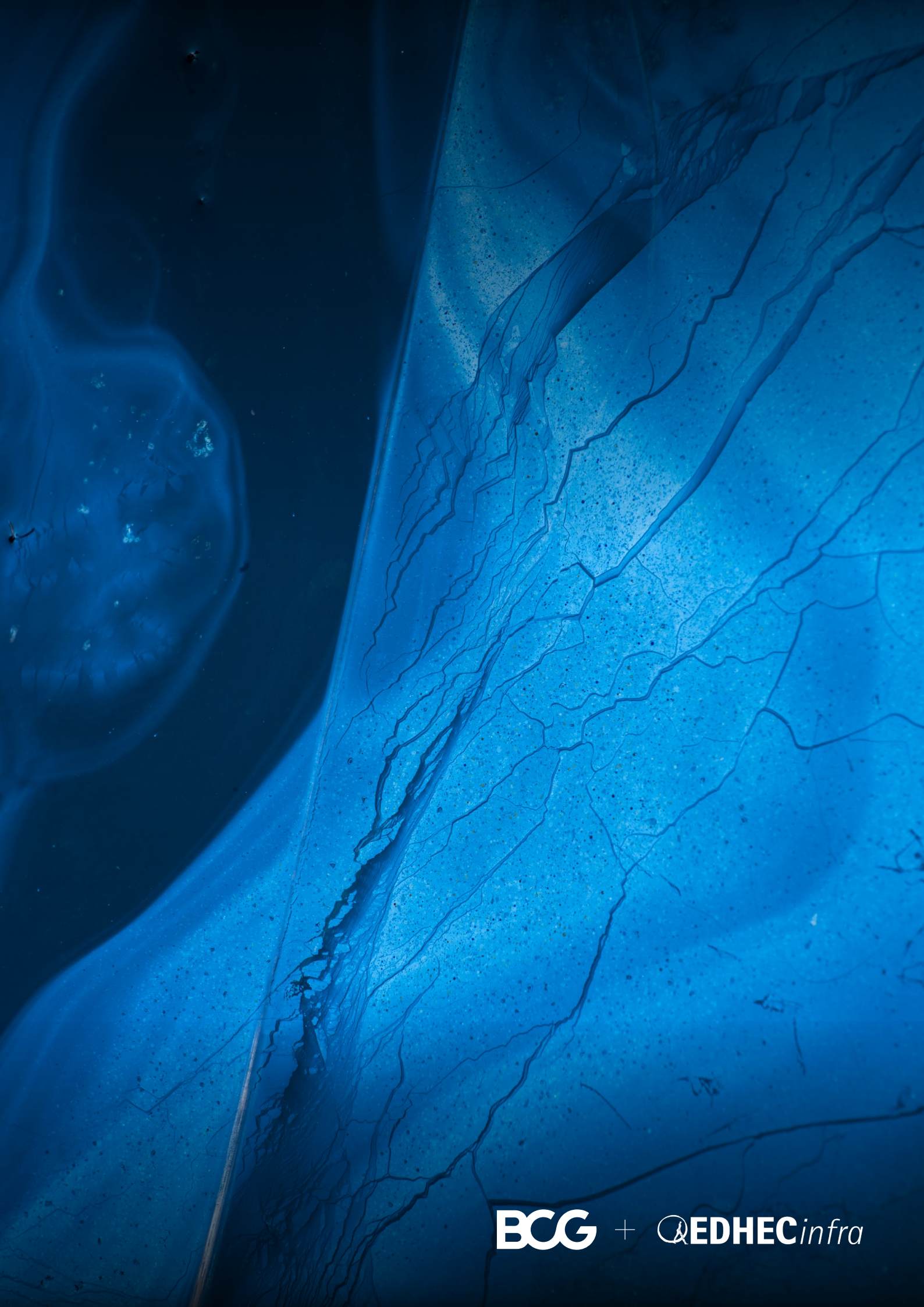
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