Infrastructure Strategy 2022

A Pivot to the Digital Frontier

March 2022

By Frederic Blanc-Brude, Wilhelm Schmundt, Thomas Bumberger, Roman Friedrich, Bernhard Georgii, Abhishek Gupta, Leonard Lum, and Maikel Wilms

BCG × EDHEC*infra*

Boston Consulting Group partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG was the pioneer in business strategy when it was founded in 1963. Today, we work closely with clients to embrace a transformational approach aimed at benefiting all stakeholders—empowering organizations to grow, build sustainable competitive advantage, and drive positive societal impact.

Our diverse, global teams bring deep industry and functional expertise and a range of perspectives that question the status quo and spark change. BCG delivers solutions through leading-edge management consulting, technology and design, and corporate and digital ventures. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the goal of helping our clients thrive and enabling them to make the world a better place.

EDHECinfra, a venture of the renowned international EDHEC Business School, is an index data, benchmarks, analytics, and research provider for investors in the unlisted infrastructure universe. We have built the largest, most representative database of underlying infrastructure investments in the world. Indices we provide help investors to measure the risk-adjusted performance of private infrastructure debt and equity within their portfolios. Our indices use the latest market information to measure the fair value of thousands of unlisted infrastructure debt and equity investments in 25 countries. We can also create customized benchmarks for individual investors who require specific TICCS® tilts in their portfolio benchmark. Our research hub, a team of experts who create and maintain our indices, is based in Singapore. We also have a business center in London to serve the financial community in Europe and North America.

Contents

Executive Summary

In 2022, global assets under management for infrastructure investments will reach a record high of $950 billion. And as the number of infrastructure investors increases, strategic questions grow in importance. How should investors select their exposures to different segments of the infrastructure universe? What risks and returns can they expect, and what strategic choices can they make to develop their portfolios? What has been the experience of different investment peer groups so far? For investors, has the direct investment model delivered as well as accessing infrastructure investments via fund managers has?

This report is the first in a series of annual publications by BCG and EDHECinfra exploring the state of infrastructure investment globally. "Infrastructure Strategy 2022" provides a new perspective on the investment styles and risk-adjusted performance of different groups of infrastructure investors. It also includes a spotlight on an investment theme expected to continue to play an increasingly significant role in the strategies of infrastructure investors: data infrastructure.

In the first part of "Infrastructure Strategy 2022," we present the results of the first global study of infrastructure investment and performance according to peer group style. Over the past two decades, pension funds and insurance companies, boutique specialist managers and larger multi-asset managers have all entered the infrastructure asset class with different priorities and focus: some have tended to invest more in renewable energy projects, while others have become more exposed to the transport sector, social infrastructure, or regulated utilities.

Geography also plays a key role in defining the strategies of different investors in a market that is also determined by national infrastructure procurement and policy choices—and whose assets are completely immobile. Each of these choices defines the style of an investor. Each peer group of investors has an investment style in common. Based on an analysis of 379 infrastructure investors in EDHECinfra's database, we compare the styles and risk-adjusted performance of 16 peer groups of infrastructure investors and provide a ranking based on their risk-adjusted returns in 2021.

In the second part of the report, we look at what infrastructure investors say they will focus on in the next three to five years and whether they expect their investment strategies to differ or remain the same. Apart from the significantly increasing importance of operational value creation, our recently conducted survey shows a clear preference for a move toward more digital infrastructure investments; we further explore the data infrastructure segment of the market and the large role fiber optic installations will continue to play in the immediate future.

Among the ideas we delve into is the notion that governments are increasingly supportive of new digital infrastructure, primarily fiber optics, because they see it as a prerequisite for digital inclusion and economic growth. Nonetheless, building out national fiber infrastructures will be a herculean task in virtually every country, requiring the replacement of fixed infrastructure that was built in the 19th century. Consequently, a dynamic infrastructure investment environment has evolved to fund these major projects.

2021 Infrastructure Investment Strategies and Rankings

To draw up 16 infrastructure investor peer groups, we examined the portfolio allocations through 2021 of 359 infrastructure equity holders using the TICCS® taxonomy of infrastructure companies and documented their exposures, or tilts. (For a detailed description of how we designed the peer groups, see Appendix 1.) These peer groups capture different types of investors, investment objectives, geographies, and regulatory or prudential frameworks. Infrastructure investor-peer-group-style benchmarks use the latest average allocations to the different segments of the infrastructure universe of each group to compute their risk and total returns and rank them accordingly. The returns and risks of each peer group are computed using their style allocation and data on the financial performance of hundreds of unlisted infrastructure equity investments. Exhibit 1 shows the profiles of 16 infrastructure investor peer groups as well as all peer groups pooled together (all investors) for the year 2021.

While investors only achieved higher returns by taking on more risk, there is a range of realized returns for different peer groups for a given level of volatility. This is because certain investors have gained exposure to different segments of the infrastructure universe over time and each segment has performed differently. Exhibit 1 shows that North American Pensions Funds had the highest risk-adjusted returns in 2021 and were in fact the top-ranked peer group. Other peer groups, such as Superannuation funds, on average took more risk to achieve lower average returns, while Canadian investors were very close to the all-investor average. At the bottom of the risk-adjusted rankings, EU and UK pension funds took less risk but also achieved comparatively lower returns.

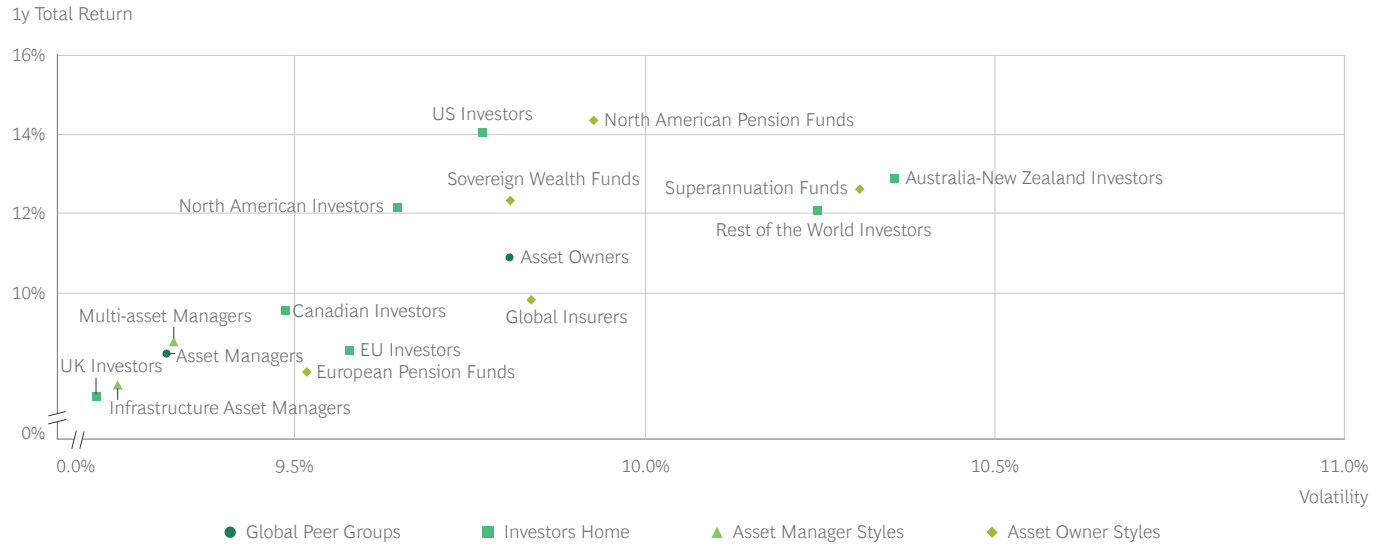
Next, we reviewed each of these peer groups and their investment styles and examined what explains their risk-adjusted performance.

Peer Group Styles Design and Ranking Approach

Peer group styles are not target allocations but represent current (as of the end of 2021) realized direct and indirect investments in unlisted infrastructure equity. This inaugural "Infrastructure Strategy" report excludes private debt and publicly traded infrastructure investments, but future versions will aim to cover these segments as well.

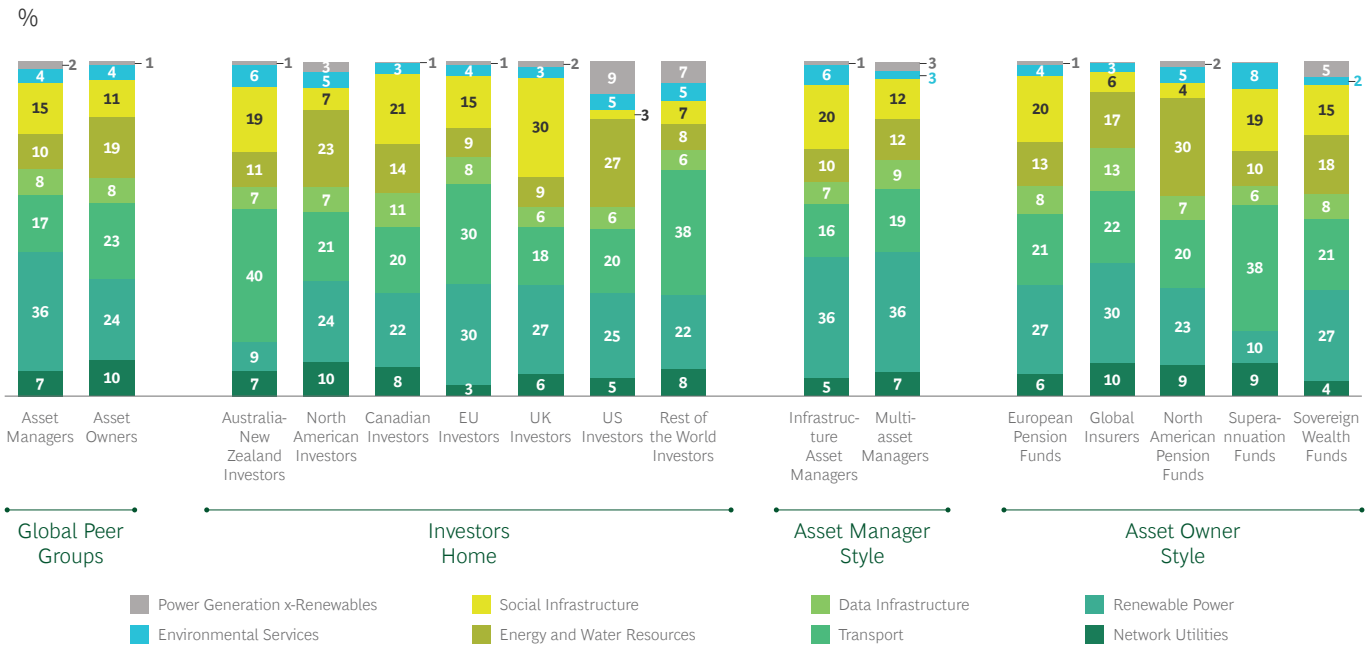
The 16 peer group styles are summarized in Exhibits 2 to 5 according to business risk, industrial activity, and corporate structure pillars, as well as geographic segments. These styles differ widely in investment exposure, risk tolerance, and home bias. They also embody different levels of access to the market for private infrastructure equity investments.

Exhibit 1 - 2021 Risk-Return Profile of All Peer Groups



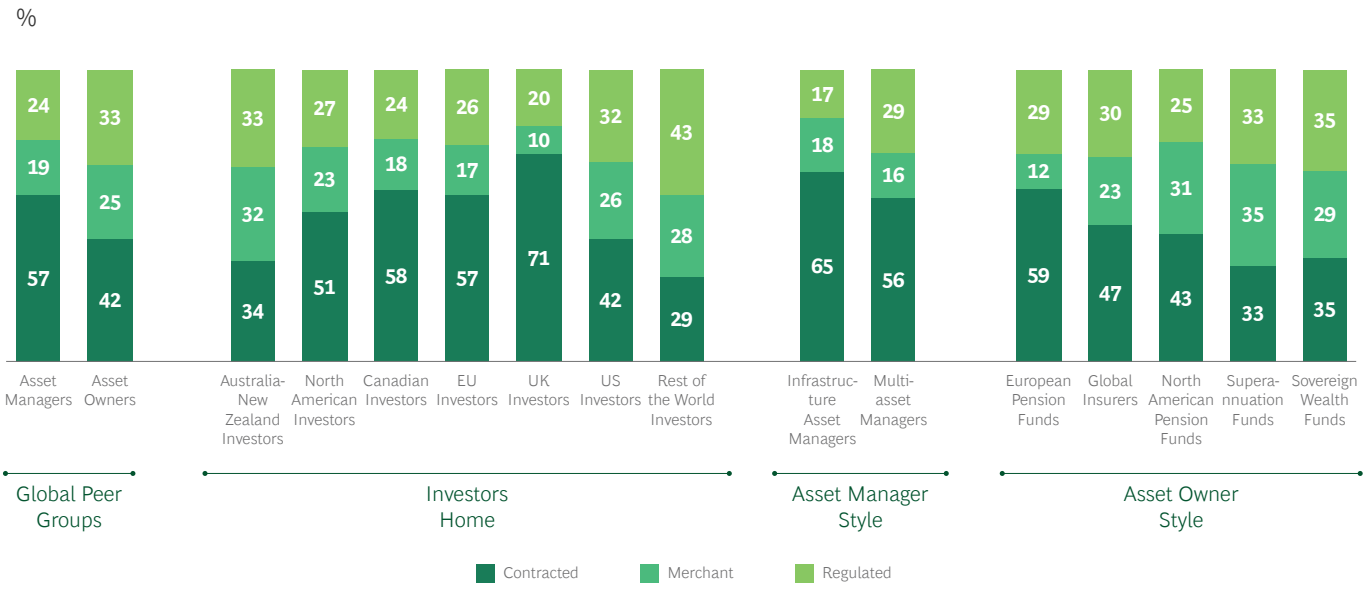
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 2 - 2021 Peer Group Investments by Industrial Activity



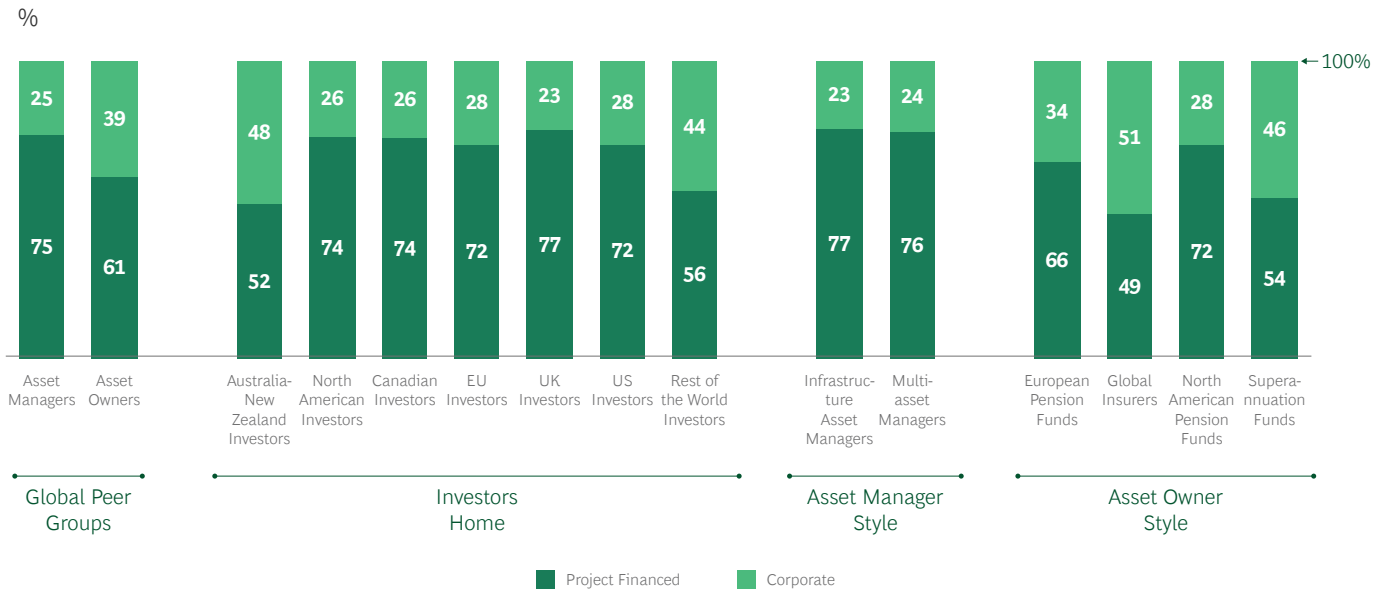
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 3 - 2021 Peer Group Investments by Business Model



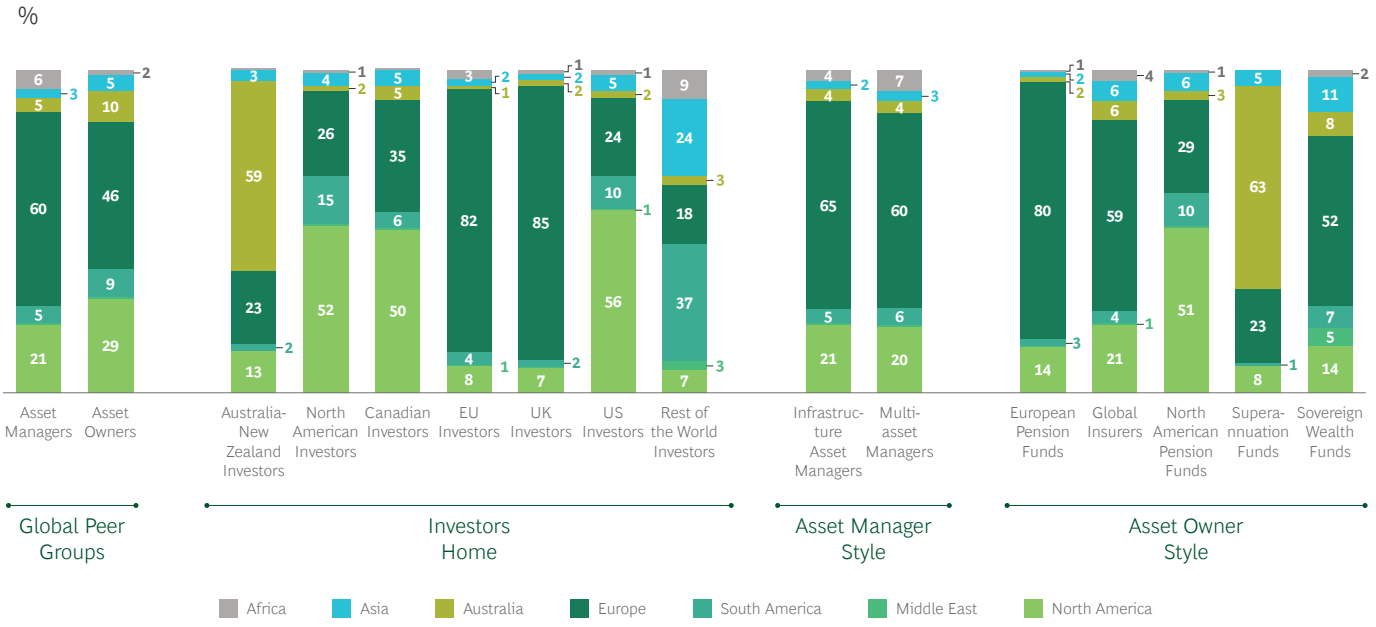
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 4 - 2021 Peer Group Investments by Governance Model



Source: EDHECinfra, infraMetrics® 2022.

Exhibit 5 - 2021 Peer Group Investments by Geography



Source: EDHECinfra, infraMetrics® 2022.

Peer group styles fall into four broad categories: Global Peers, Home Peers, Manager Peers, and Asset Owner Peers. Peer groups are ranked within their category based on their 2021 risk-adjusted returns (Exhibit 6).[1]

Peer group performance is presented in gross costs. In practice, investors face investment costs: direct investment in infrastructure includes significant transaction costs, and indirect investment via managed funds requires paying management fees and carry. As a result, investors' realized returns would be different than those presented here for the purpose of benchmarking peer group styles. We use gross returns to provide a cost-agnostic view of performance across styles and a like-for-like measure of risk-adjusted returns to rank and measure relative performance across peer groups.

Exhibit 7 shows the equivalent of the peer group styles expressed as Core, Core+, and Opportunistic risk buckets. (Unlike peer group rankings, these categories represent investor styles by appetite for risk taking, from low to high.) Finally, Exhibits 8–10 show contributions of the industry segments to the one-year total return. They are computed as the combination of the weight of the peer group in that segment and the performance of that segment, with each contribution shown in basis points and adding up to the 2021 total return of each peer group.

Global Peers

There are two Global Peer Group styles: asset managers (a.k.a. General Partners) such as private equity funds and asset owners (a.k.a. Limited Partners) such as pension funds, endowments, and sovereign funds. In 2021, a group of 79 asset owners ranked first by gross risk-adjusted returns (10.86%, with a Sharpe ratio of 1.1), ahead of 280 asset managers with an average risk-adjusted return of 8.44% and a Sharpe ratio of 0.9.

Asset manager portfolios are more heavily invested in lower risk, ***contracted*** business models, in which infrastructure providers have long-term revenue agreements with the public sector or private companies to deliver specific services. About one-third of their portfolios consist of project-financed renewable power projects. Their bias toward contracted renewables projects is indicative of the more specialized nature of many asset managers. The Global Asset Manager Peer Group is also mostly exposed to European investments (60%), while only a fifth of assets are found in North America.

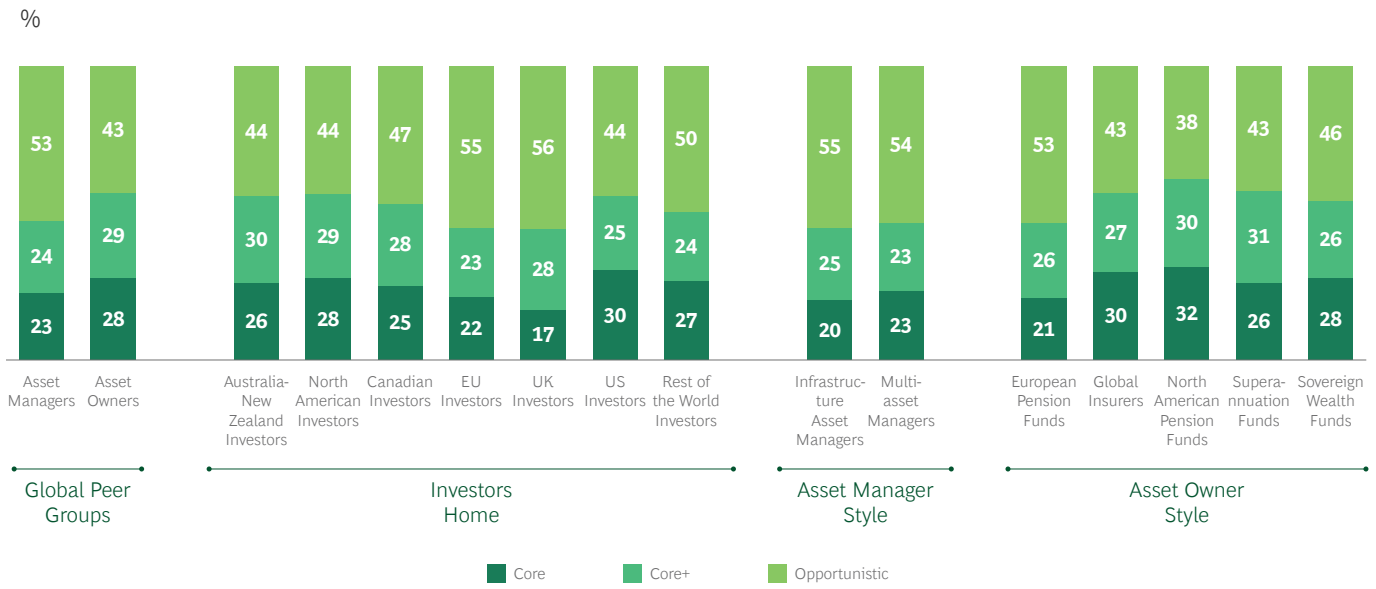
1. Starting with the allocation of the infra300® index, which represents the overall infrastructure market, we rescale the weights of the underlying constituents with the constraints to match the TICCS style of each peer group. infraMetrics gross unlisted equity returns in local currency are then used to build each style benchmark. The style of each peer group is assumed constant for the past three years. To get a robust estimate of volatility, we use a 10-year (120 data points) standard deviation of returns measure, holding the style constant. Peer group styles are then ranked by category based on their 2021 risk-adjusted returns (Sharpe Ratio, computed using the 1-year excess return (subtracting the 1-yr risk-free rate in each market from total returns) and the standard deviation of monthly returns time series over 10 years).

Exhibit 6 - 2021 Risk and Return Performance of Peer Groups

Peer Group	Rank	1y Total Return	3y Total Return	Volatility	1y Sharpe Ratio
Global Peer Groups					
Asset Owners	1	10.86%	10.53%	9.81%	1.10
Asset Manager	2	8.44%	10.67%	9.32%	0.90
Investors Home					
U.S. Investors	1	14.02%	13.84%	9.77%	1.43
North American Investors	2	12.12%	12.13%	9.65%	1.25
Australia-New Zealand Investors	3	12.85%	9.79%	10.36%	1.23
Rest of the World Investors	4	12.04%	10.54%	10.25%	1.17
Canadian Investors	5	9.50%	10.28%	9.49%	0.99
EU Investors	6	8.50%	10.01%	9.58%	0.88
UK Investors	7	7.34%	10.50%	9.22%	0.79
Asset Manager Styles					
Multi-asset Managers	1	8.74%	11.00%	9.33%	0.93
Infrastructure Asset Managers	2	7.64%	10.56%	9.25%	0.82
Asset Owner Styles					
North American Pension Funds	1	14.36%	12.06%	9.93%	1.44
Sovereign Wealth Funds	2	12.33%	10.72%	9.81%	1.26
Superannuation Funds	3	12.61%	9.70%	10.31%	1.22
Global Insurers	4	9.80%	10.10%	9.84%	0.99
European Pension Funds	5	7.98%	10.28%	9.52%	0.84
All Investors		**9.65%**	**10.60%**	**9.55%**	**1.01**

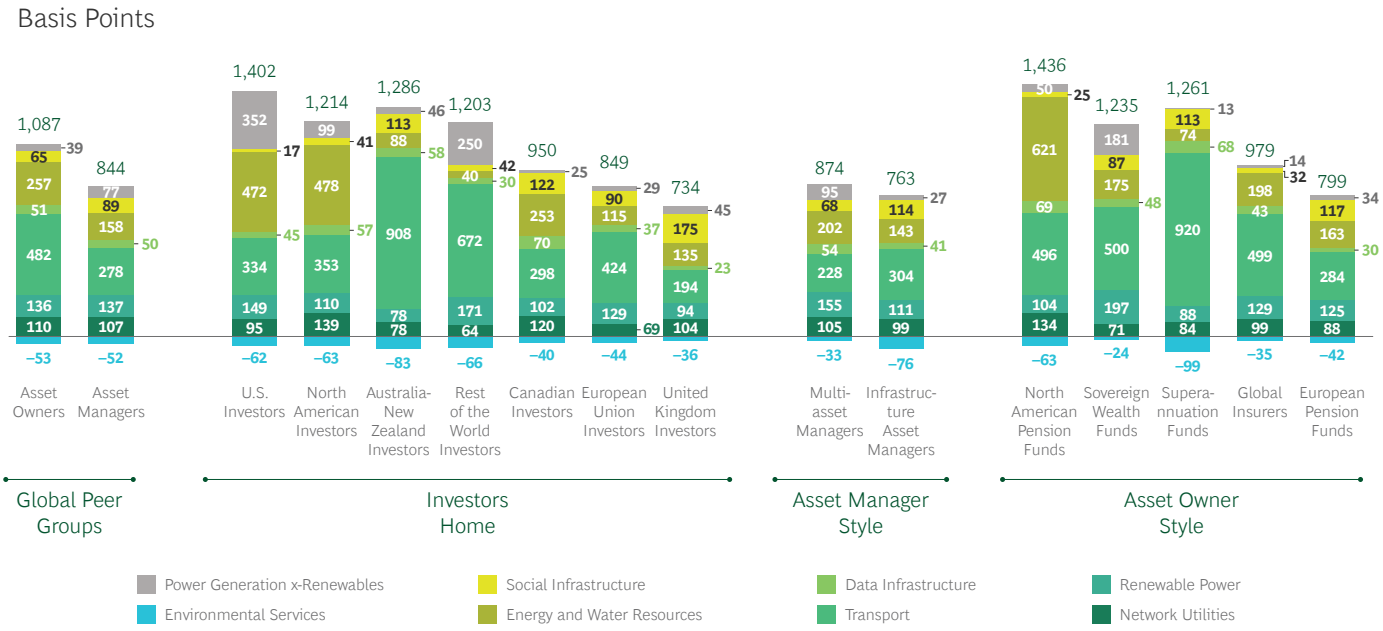
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 7 - 2021 Peer Group Investments by Core, Core+, and Opportunistic Styles



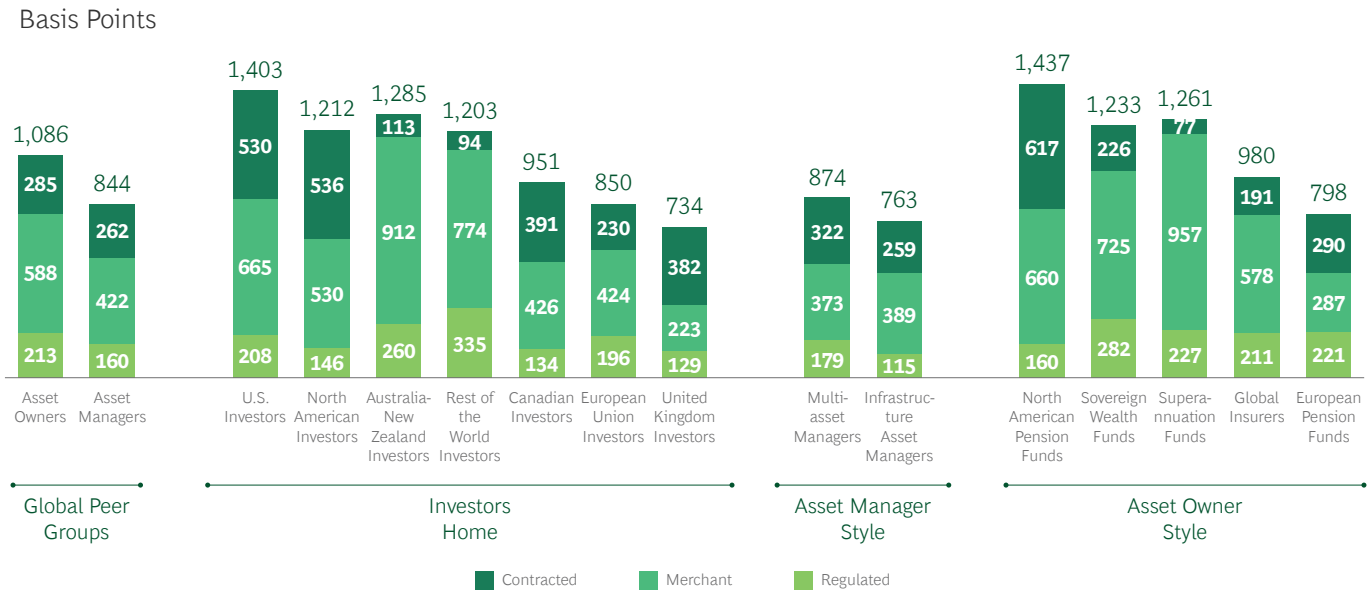
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 8 - 2021 Total Return Contributions by Industrial Activity



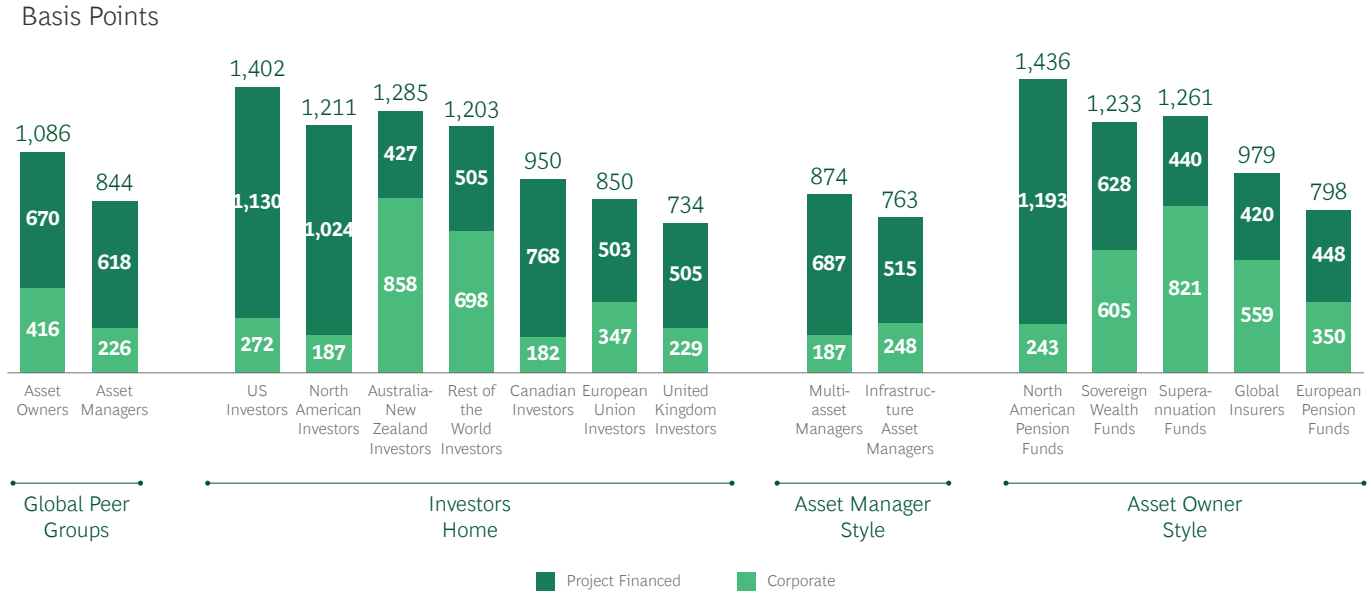
Source: EDHECinfra, infraMetrics® 2022.

Exhibit 9 - 2021 Total Return Contributions by Business Model



Source: EDHECinfra, infraMetrics® 2022.

Exhibit 10 - 2021 Total Return Contributions by Corporate Governance



Source: EDHECinfra, infraMetrics® 2022.

By contrast, asset owners appear to be less risk averse, with about 60% of their investments in merchant and regulated corporates and a higher allocation in the riskier Energy Resources and Transport sectors. Global asset owners have less than 50% of their infrastructure assets invested in Europe and close to 30% in North America. As the Canadian model exemplifies, part of asset owners' portfolios consist of ***direct*** investments in infrastructure. These investors have tended to invest more in large corporates (utilities, airports, etc.) as shown in Exhibit 4. It is also possible that they have somewhat less access to project finance transactions, especially greenfield projects that require winning a public tender. There is also anecdotal evidence of a preference for so-called "trophy" (i.e., large) assets to deploy capital fast. As a result of this bias toward transportation and power in particular, the Global Asset Owner Peer Group style benefited from the strong post-Covid performance of these sectors in 2021, as shown in Exhibit 7.

While global asset owners out-ranked global asset managers in 2021, they would not have on a 3-year (2019–2021) basis (Exhibit 6).

Home Peers

There are seven Home Peer Groups defined by the geographic origin of investors, such as North American, EU-based, and Canadian. Peer group styles and performance vary considerably by geography of origin: U.S. investors ranked first by realized risk-adjusted returns in 2021 (Sharpe ration of 1.43, see Exhibit 6), followed by the broader group of North American investors (Sharpe ratio of 1.25). This exceptional performance was driven by the much higher exposure to conventional merchant power (coal and gas) and energy resources (among them also gas pipelines) of these investors (Exhibit 2 and 3). These investors also showed the strongest home bias, with more than 50% of their assets located in North America.

However, still in North America, the Canadian Investor Peer Group ranked fifth in the Home Peer Groups with a lower Sharpe ratio of 0.99. Compared with U.S. investors, the Canadian Peer Group is exposed to less conventional power and much more social infrastructure, which tends to have a more stable, contracted business profile. On a risk adjusted basis, this stance did not pay off as well in 2021 as that of its U.S. neighbors.

Third and fourth in the rankings of Home Peer Groups were Australia and New Zealand investors and the "Rest of the World" group, respectively, which mostly includes investors from Asia and the Middle East. Like U.S. investors, Australian investors have more merchant and regulated assets in their portfolios; however, they are more exposed to transportation investments and less to conventional energy supply and generation. These investors also exhibit a significant home bias, with close to 60% of their investments located in the same region (Exhibit 5).

EU and UK investors ranked last in the Home Peer Group ranking due to lower returns that were not compensated for by a commensurate reduction in risk. EU investors are as exposed to renewable energy projects as UK investors are but much more to transport investments that tend to be merchant or regulated (Exhibits 2 and 3). These two peer groups invest almost exclusively in Europe, with less than 8% of their assets located in North America.

The impact of the 2021 post-Covid recovery on asset prices explains that year's rankings to the extent that investors were more exposed to both transport and energy and merchant and regulated business models. Looking at the 3-year performance (Exhibit 6), North American and U.S. investors would still top the Home Peers ranking, but Australian investors would be at the bottom of the list due to their exposure to transportation, especially airports, and the impact of Covid on air travel.

Asset Manager Peers

Asset Manager Peers include either specialist infrastructure managers or larger multi-asset managers. In 2021, the Multi-Asset Manager Peer Group topped the rankings with a Sharpe ratio of 0.93, ahead of specialized fund managers with a Sharpe ratio of 0.82.

The main style differences between pure-play and multi-asset managers echoes that between global asset managers and asset owners: specialist asset managers tend to invest more in contracted projects, social infrastructure, and utilities, while multi-asset managers invest more in merchant and regulated assets, power and energy resources, and transport.

Again, the higher exposure of multi-asset managers to sectors and business models that benefited from the post-Covid recovery led to a better 2021 performance. In general, however, both Asset Manager Peer Groups showed total returns in 2021 that were below the "all investor" average of 9.65% and Sharpe ratio of 1.0.

While investors achieved higher returns by taking on more risk, there is a range of realized returns for different peer groups.

Asset Owner Peers

The Asset Owner peer category includes five peer groups: U.S. Pension Funds are the best-ranked peer group for reasons such as the ones previously highlighted for the North American Peer Group. They tend to be underfunded and allocate more to the performance-seeking portfolio, hence a greater exposure to merchant assets.

Sovereign Wealth Funds ranked second with a gross Sharpe ratio of 1.26—one of the most geographically diversified peer groups and the most-exposed to regulated assets in this category. It also has a greater exposure to power, second only to U.S. investors.

Superannuation funds ranked third in this category with a Sharpe ratio of 1.22. They generated most of their returns from transport investments and less from renewable power than other peer groups did, and were not compensated for by a greater exposure to conventional power. In line with the Australian and NZ Peer Group, Australian Super funds were exposed to more transport and more merchant risk and corporates than most other peer groups were.

Global insurers came in fourth, with a gross Sharpe ratio of 0.99. Unlike other groups, they invest truly globally with a focus on Europe and the U.S., and have an unusual 50/50 exposure to projects and corporates, which they only share with the Australia/NZ Peer Group. Like other investors, insurers benefited from transport and gas rebounding in 2021. Note that global insurers almost completely shun conventional power but still adopt a yield-seeking style when it comes to infrastructure, as opposed to a lower-risk, liability-hedging style.

Finally, European Pension Funds ranked last in this category with the lowest Sharpe ratio and also the lowest portfolio volatility. They have the lowest allocation to Merchant assets of all the peer groups in this category and invest instead in contracted transport, social, and renewable projects, adopting a distinctively more risk-averse style.

Core and Core+ Styles by Peer Group

We use a definition of Core, Core+, and Opportunistic infrastructure investments based on the 5-year average expected returns of individual assets. Using a risk-based approach, investments in the first two quartiles of expected returns are considered Core, those in the third quartile Core+, and the companies in the top quartile of expected returns Opportunistic.

Exhibit 7 shows that all peer group styles include some exposure to all three segments, but are in line with earlier findings, with UK investors the least exposed to the Opportunistic style and North American pension funds the most exposed. Note that EU investors and multi-asset managers are also the most exposed to Core strategies.

Peer Group Investment Style Facts

Several investment style facts emerge from our findings:

- The 2021 post-Covid recovery was strong, leading to high returns and a bull market average Sharpe ratio of 1.0. This recovery benefited some peer groups more than others and transport and energy investors were able to make up for some of the losses they had incurred in previous years.

- Renewable energy is everywhere in investors' portfolios. With the notable exception of Superannuation investors, who have put significantly less weight on renewable power investments, all infrastructure investor styles now include a quarter to a third of renewable energy projects.

- Power and gas still pay. After transport, the main beneficiary of the 2021 recovery, especially since wind levels were lower than usual, was gas and conventional power generation. Those peer groups that stayed more exposed to these sectors benefited, while peer groups that had already mostly divested conventional power generation from their portfolios did not.

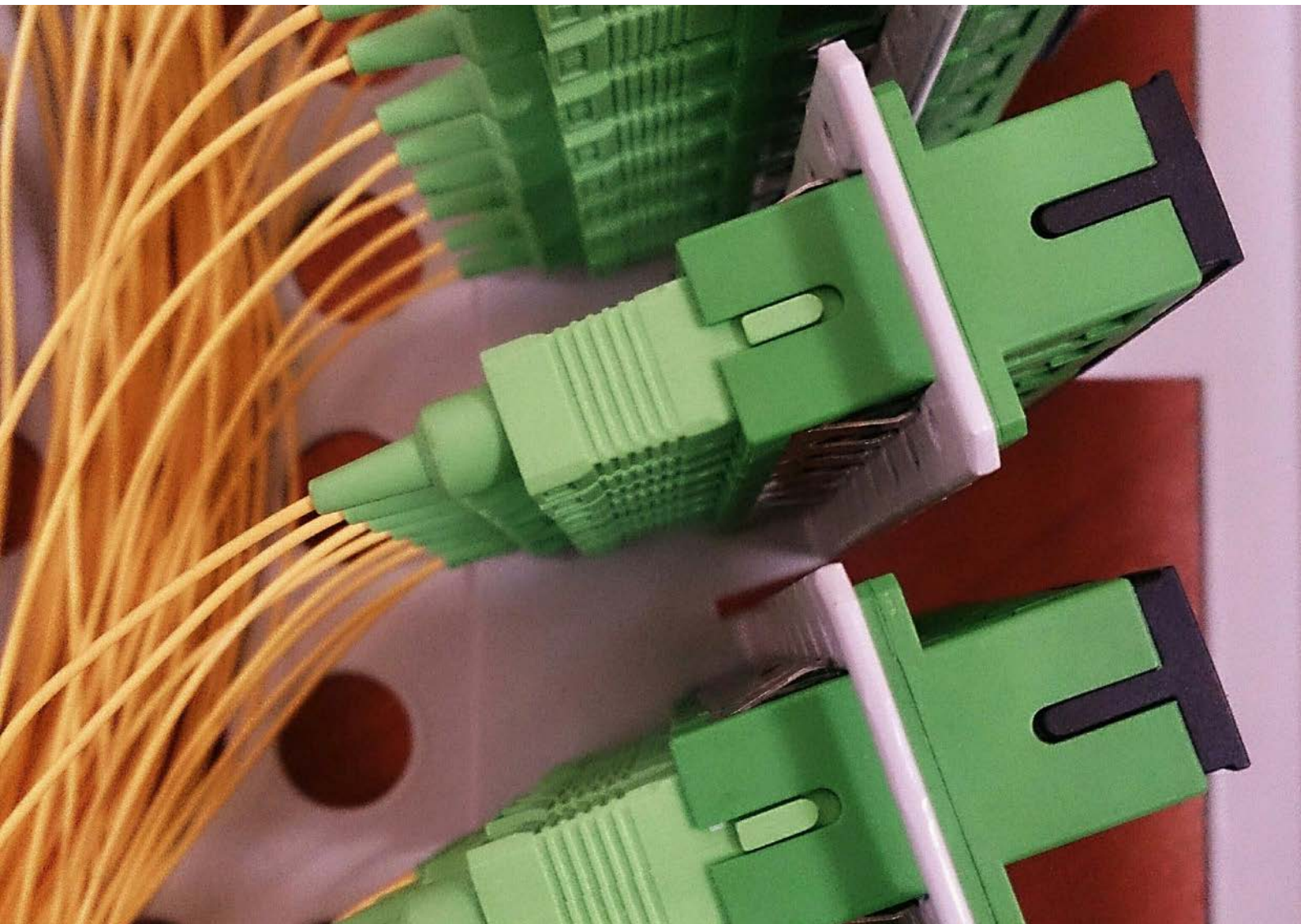
- While infrastructure investment used to be equated with airport and utilities acquisitions, the contracted infrastructure projects are now the basic building block of almost every infrastructure investor's portfolio and represent between 50 and 70% of infrastructure assets under management (AUM) across all peer groups. Still, infrastructure corporates remain part of the infrastructure mix, and all peer groups are also exposed to them, albeit in varying amounts.

- Like renewables, data infrastructure is the infrastructure of the future. However, unlike wind and solar projects, it has yet to grow into a significant part of the style of the various peer groups.

The next part of this report delves deeper into the future of digital infrastructure.

Peering Into the Future

Operational Value Creation and Digital Opportunities



Examining infrastructure investment behavior and the types of investments favored by investors, our survey generated intriguing results about the status quo today—*as discussed in depth in Part I of this report*—and a likely sharp shift in the relatively short term (next three to five years).

The survey found that among Core, Core+, and Opportunistic asset managers and owners, digital infrastructure will be an investment priority in the immediate future, while interest in other investment sectors will wane (see Exhibit 11).

The survey also indicated significant movement in how infrastructure investors view the importance of operational value creation now and in the immediate future (see Exhibit 12). Although many "classic" private equity investors have for a long time seen operational value creation as an imperative, infrastructure investors have in the past often made value gains less of a priority. The thinking was that value on big infrastructure projects, such as major roads, would grow over longer periods, during which time cash flow would often provide a financial cushion.

However, as the survey found, more than half of asset managers in primary investment categories have already changed their minds about this and view operational value creation as important. In addition, most of the minority that doesn't see it that way now concedes that value creation will be important within the next five years.

Both the increased focus of infrastructure investors on data and digital infrastructure and the growing pressure for sustainable value creation shine a spotlight on one particular category of investments: fiber optics.

The Impact of Digital Infrastructure Growth on Fiber Optics

It is not difficult to see why investing in digital infrastructure is a potentially lucrative strategy: the need for internet connectivity is ballooning in virtually every corner of the world. And the increasing desire for higher speeds and reliable online access will inevitably lead to a huge expansion of fiber optic installations in new networks in low- and middle-income nations as well as in existing networks in higher-income countries. Ultimately, fiber, which has already begun to make inroads in networks everywhere, will replace legacy (primarily copper) infrastructure completely, particularly as 5G rolls out (see Exhibit 13).

BCG estimates fiber availability levels of more than 80% within the next 10 to 15 years in all developed markets. In some European countries—among them Norway, Sweden, Spain, and Portugal—fiber optic penetration has already topped 50%.

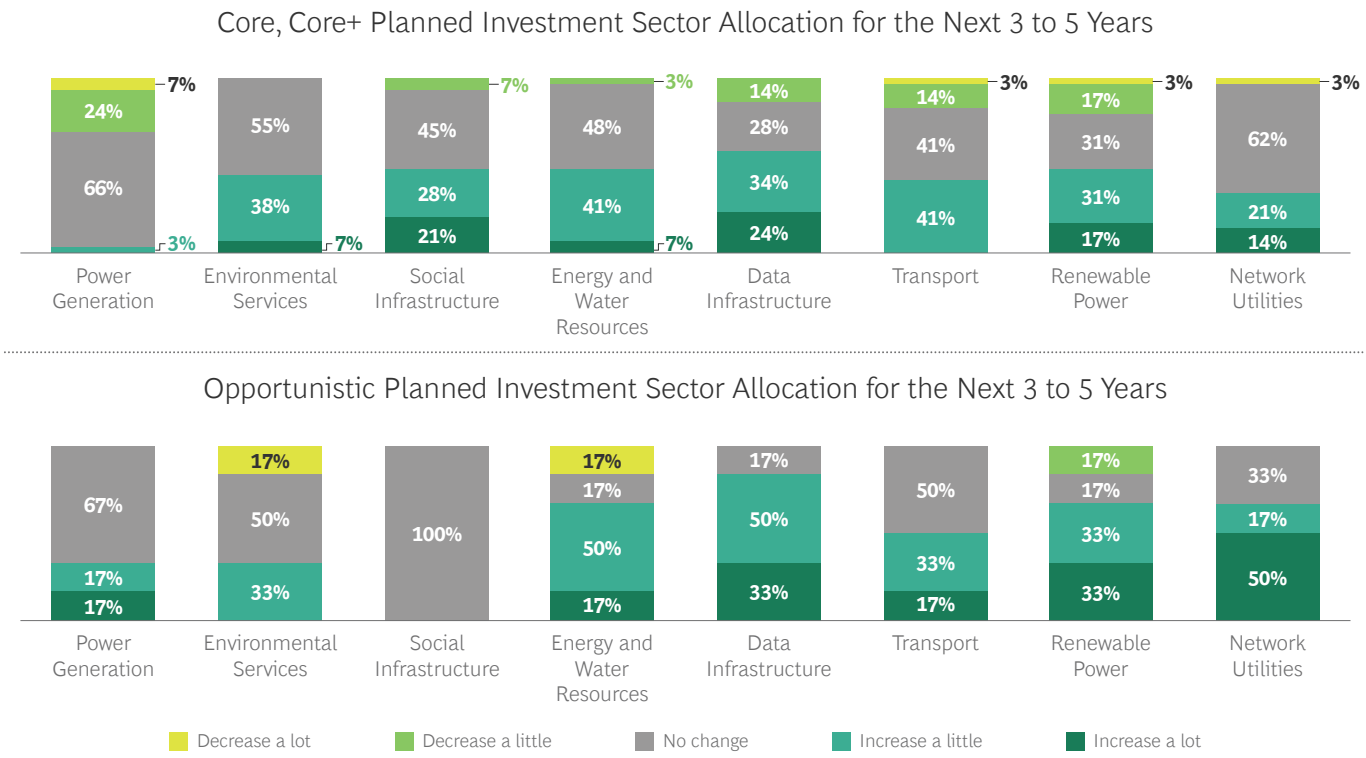
These high fiber-penetration levels are still the exception, however. Indeed, although the internet may seem ubiquitous to many of us, this is a bit of an illusion (see Exhibit 14). Only about half of the world was using the internet in 2019, according to the International Telecommunications Union. By 2021, that figure had increased to 63% of global population, or 4.9 billion people.

With so much looming demand, we expect that many of the digital infrastructure projects kicking off in the next few years will involve extending fiber optics to more premises and other locations such as cell towers. In fact, the tilt toward fiber optic investments has already begun, and forecasts indicate that this funding growth will continue and sometimes even accelerate in lower-income countries. There have already been some big announcements on that front, such as the recent $1 billion investment in an Indian fiber optic project by an Abu Dhabi sovereign fund. This is in addition to a plan in India to invest $1.3 trillion in connectivity-related infrastructure that will provide fiber optics to more than 600,000 villages.

Although demand for fiber optic projects is most pronounced in less-wealthy economies—large and diverse regions with significant potential, such as Nigeria, Ghana, South Africa, Brazil, and parts of Asia are untapped markets—fiber penetration is also uneven in places where economic growth is less uncertain. For instance, in China, upwards of 80% of telecommunications networks serving businesses are driven by fiber optics, but only 20% of homes have fiber connectivity.

In the U.S. and Europe, similar discrepancies can be found among urban, semi-rural, and rural areas. For instance, in Northern Ireland, 85% of urban areas have fiber connectivity while only 36% of rural areas do. And sometimes the digital divide goes beyond separating urban and rural zones, as in some higher-income countries wildly different penetration levels can be found even between neighboring cities.

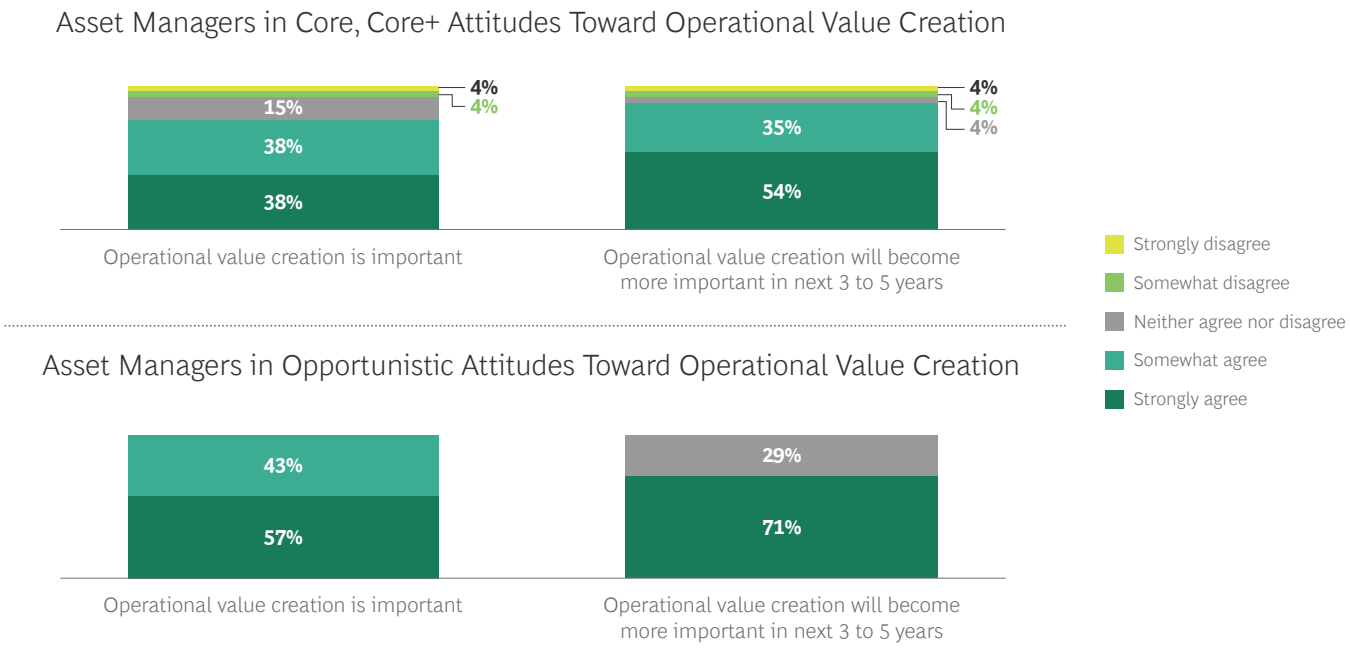
Exhibit 11 - Asset Managers and Owners Expected Investment Focus



Source: BCG analysis.

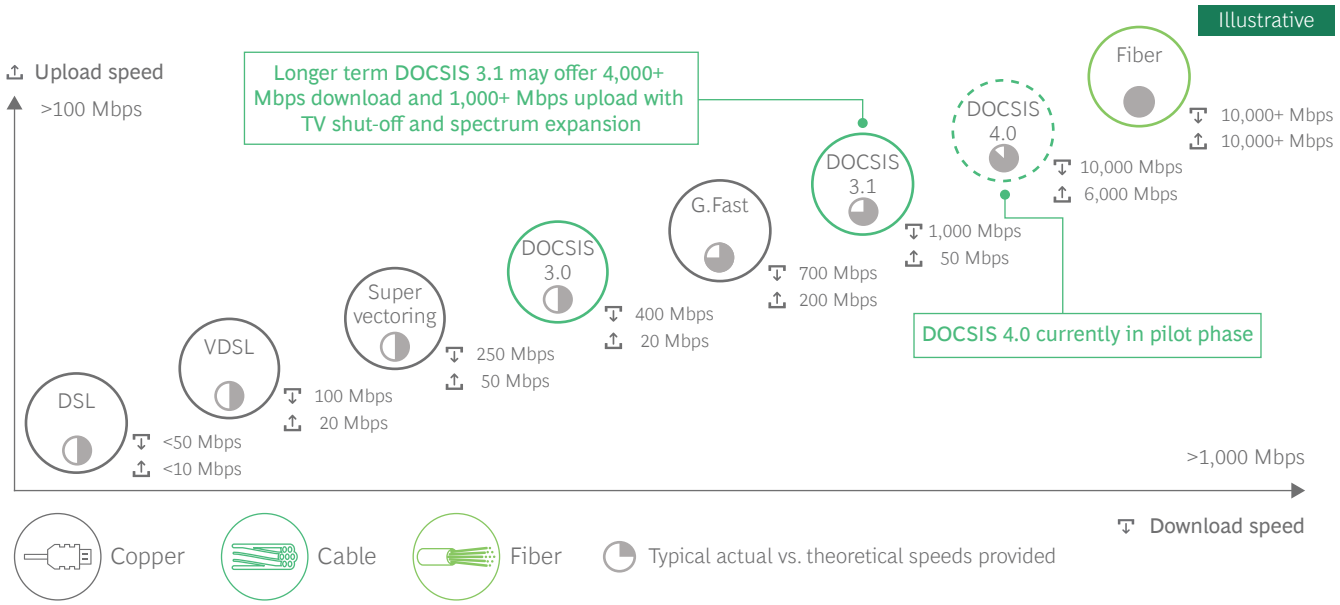
Note: Number of survey participants = 108.

Exhibit 12 - Attitudes Toward Operational Value Creation Importance



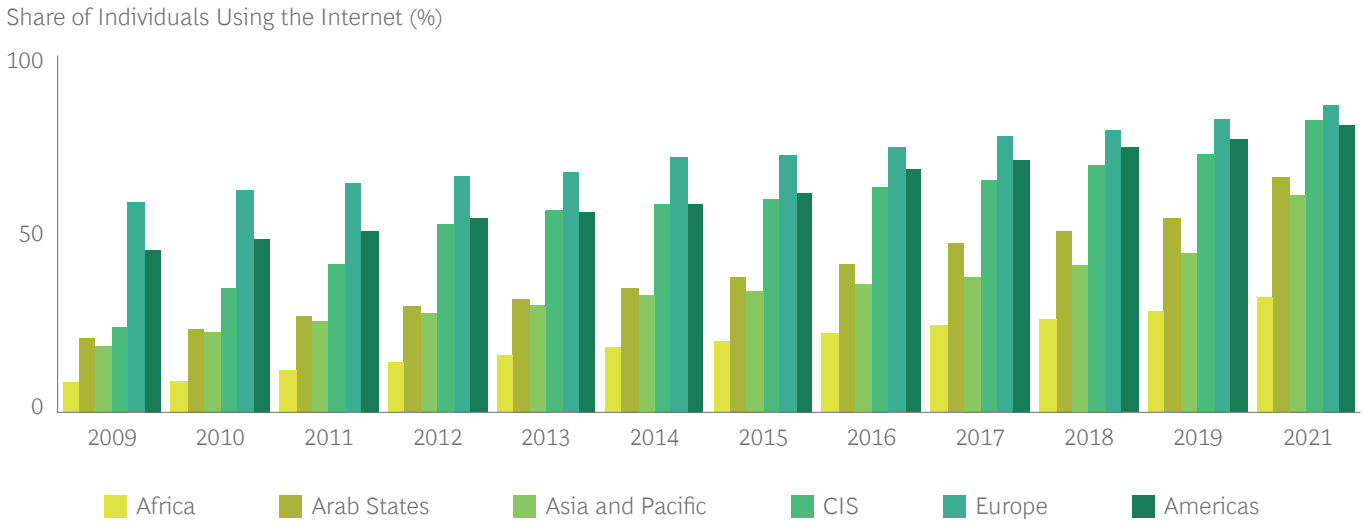
Source: BCG analysis.

Exhibit 13 - Speed Range of Different Broadband Connections



Source: Analyst reports and whitepapers; BCG analysis.

Exhibit 14 - Global Internet Penetration Rate from 2009 to 2021, by Region



Source: Statista 2022.

But despite all these varying statistics, there is clear evidence that access to fast internet is a strong underlying driver of economic growth and broader socioeconomic benefits. Indeed, a 2018 World Economic Forum study found that a 10% gain in internet penetration can increase GDP growth by up to 2.8%age points. And when download speeds are doubled, per capita GDP growth can rise by about 0.3%age points.

Given the strong connection between fiber infrastructure projects and economic improvements, governments are beginning to move funds in the direction of these efforts, giving fiber network companies yet more motivation to jump wholeheartedly into the market and investors to move funds into public/private ventures involving fiber optics. For instance, recently passed U.S. infrastructure legislation earmarks more than $40 billion to providing fiber-based high-speed internet for Americans. And 25% of the EU post-pandemic recovery fund is slated to be spent at digital projects.

The Fiber Optic Business Landscape

Growing fiber demand is a given—and that demand will significantly alter the telecommunications business environment. A wide range of companies will play key roles in fiber rollouts and there will be significant investment opportunities for investment managers and investors. In our view, the dominant companies leading fiber optic efforts can be broken down into four categories, with distinct strengths and weaknesses to each:

1. **Legacy telcos** can use their existing operating model and sales force to deploy fiber and 5G. They can also offer fiber networks to whole buyers, such as internet service providers (ISPs), for further utilization.

   Strengths: For some, limited expertise in fiber installations; a customer base to migrate; existing assets and facilities that should make installing fiber less complex; strong local political relationships to rely on to cut through permitting red tape.

   Weaknesses: Many lack fiber rollout capabilities since their core business for decades has been to manage networks rather than install them; with deep investments in existing copper networks, revenue gains are restricted to the delta between available receipts from fiber and copper, which in turn may be constrained by customers' willingness to pay more for fiber and by pricing regulation.

2. **Pure fibercos** are newly created businesses established to bring fiber connectivity to unpenetrated areas, particularly rural regions, often as a joint venture between telcos and private investment funds. They may be retail- or wholesale-based.

   Strengths: State-of-the-art deployment technologies; a lean organization with no legacy burden; attractive to investors, so well funded; can take advantage of cheap money in lending channels.

   Weaknesses: No customer base to migrate; non-existent synergies with existing infrastructure; a lack of access to construction companies due to low build-out volumes; few previous relationships with local political authorities.

3. **Netcos** are businesses carved out of integrated telcos, established to accelerate fiber rollout. Netcos can focus on rollout and do not need to consider the often more short-term-oriented telco needs.

   Strengths: As pureplay companies, they are attractive to investors in digital infrastructure; better positioned to derive independent wholesale business because their focus is to build infrastructure and sell it in bulk to retailers; access to existing telco networks and equipment can provide operational and infrastructure advantages and immediate cash flow, in contrast to fibercos.

   Weaknesses: Difficulties in managing legacy technologies; operational complexity of carve-out of a much larger company; dependency on a single large telco as a service provider.

4. **Public-Private Partnerships** are a good option for rural areas, with governments subsidizing these efforts in order to expand broadband into remote regions. Alternatively, the state would build the digital infrastructure in these regions without any participation from private companies.

   Strengths: Combines the operational efficiencies and discipline of private companies with government subsidies to support fiber optics installations in areas that are otherwise commercially not attractive because of, for example, limited household density or buying power; the potential of using state-owned assets—such as railways or electric lines—to support infrastructure projects; the possibility of governments accelerating administrative processes to reduce the regulatory burdens on private company partners.

   Weaknesses: Even with government support and cooperation, private companies often face significant delays due to bureaucratic policies and red tape.

In addition to these four company categories, construction firms and OEMs play a role in the global fiber optics rollout. Trying to keep up with increasing demand for traditional construction efforts and telecommunications projects, firms are already struggling to find enough workers willing to do low-skilled labor, such as earth digging, for relatively low wages. As that shortage is exacerbated over the next few years, construction company availability and fees will be a central component in the cost/benefit calculations and strategic decisions surrounding fiber optic projects. To a lesser degree, but significant nonetheless, OEMs producing fiber optics and telecommunications equipment will also have to scurry to meet supply chain demand. Unanticipated equipment shortfalls that ultimately affect the timing and scheduling of fiber optic installations would not be surprising.

Healthy Fiber Optic Returns

The strength and potential of the fiber optic market can be easily seen in the financial performance of companies involved in this sector, as well as in their valuations as takeover candidates.

Viewing fibercos through the lens of Enterprise Value/EBITDA, a well-regarded ratio for measuring a company's full market value, these firms were generally at about 3 to 5 a decade ago. By 2020, top businesses in this sector had EV/EBITDA ratios of well over 15 with a few as high as 27 and more than two times premium of sales over capital expenditures for deployment. In contrast, classical telcos trade at between 6 to 9, with cable companies at the high end of the range, integrated telcos in the middle, and mobile-only players at the lower end.

In addition, in recent M&A activity, pure fibercos have been acquired at robust multiples—as much as 13 times EV/EBITDA valuations and 2 times capital expenditures. Netcos have had somewhat more restrained but still impressive valuations—averaging about 10 times EV/EBITDA. The difference stems from the idea that fibercos are free of legacy company entanglements and hence are less encumbered when seeking retail and wholesale partnerships to better monetize the infrastructure. Also to their benefit, fibercos generally have a larger growth trajectory ahead of them and a higher presence in rural areas with less competition, derisking the revenue streams.

Success Factors in Fiber Investments

If their track record is any indication, the raft of new fiber optics projects anticipated during the coming years could be a profitable opportunity for infrastructure investors, who are already interested in making digital installations a priority. But, as is appropriate for all investments, due diligence is necessary—particularly understanding the fundamentals that drive the best returns. In our view, three levers primarily influence return on investment (ROI):

- **Optimized fiber network utilization**

  To ensure that a new fiber project has the widest customer base possible, companies need to extend their retail and wholesale capabilities as far as possible. Although legacy telcos and netcos linked to them may be more hesitant about sharing sales with ISPs and other wholesalers, for a fiber optic project to realize its greatest returns, partnerships and joint ventures are usually essential. Additionally, companies must use customer analytics software and internal analyses to ensure that their prices are in a range that both encourages sign-ups and retains them for the long haul. The goal should be to become the first and sole fiber optic provider in a region, selling access to others and discouraging competitors from taking on the huge capital expense of building their own network when, at best, they will be an also-ran.

- **Low CAPEX due to operational efficiencies**

  Capital expenditures on a fiber project can be reduced in the design and build stages by using the latest technologies, including AI-based automated programs, to plan the construction process and monitor each stage, with the goal of keeping the project on schedule and avoiding rework to fix mistakes or make up for deviations from the original plan. Also, modern and efficient digging advances, such as micro-trenching, should be adopted along with smart and cost-effective deployment concepts—such as façade rollouts and over-the-air connections—for linking fiber to homes and offices. And since labor accounts for 80% of the costs in any CAPEX project, access to inexpensive work crews is essential to deliver high ROIs.

- **High average revenue per customer**

  Beneficial price realization is critical for successful fiber optic projects, especially in environments with multiple competitors. The best pricing strategy to propel revenue per customer higher could be called "more for more." That is, fiber companies must sell their copper replacements as an advantaged approach, providing features and improvements customers missed out on before. In other words, higher prices for more bandwidth, greater reliability, and targeted service bundles (e.g., packages aimed at businesses, or maybe gamers, that need greater speed).

Perhaps the best argument for accelerated fiber optic implementation is that these projects perfectly combine growing demand and socioeconomic and environmental benefits (because they are more energy efficient) with a willing and often eager investor community. Although building new nationwide digital infrastructure is always a huge and expensive task, particularly when century-old, fixed infrastructure is being replaced, installation costs will continue to drop as technological advances improve implementation efficiency. And long-term investments will become more attractive as these projects deliver stable returns.

In producing the "Infrastructure Strategy 2022" report, BCG and EDHECinfra seek to provide a new way of looking at the investment strategies of infrastructure investors and highlight the types of investments that are in favor today and will be preferred tomorrow.

Clearly, risk has been and will likely continue to be rewarded. At the same time, support for infrastructure investments will accelerate as governments increasingly upgrade their physical and digital infrastructure to better compete on the global stage. Faced with increasingly creative and technologically advanced projects, funding from the private sector and private investors will also expand in size, scope, and imagination.

Appendix 1

The TICCS Classification

Peer groups are based on styles defined by the TICCS standard. It is a common classification standard that can be used by all investors across various stages of the infrastructure-investment value chain. It captures the characteristics of all infrastructure investments by industry, business risk, and corporate governance structure. It is also reviewed regularly by industry participants as new markets and companies are added to the EDHECinfra database.

The Global Infrastructure Company Classification Standard (TICCS) was created to provide investors with a frame of reference to approach the asset class.

It is designed to be compatible with other standard investment-classification schemes; however, it also uses fundamental insights from the academic literature to create a classification that embodies some of the key aspects of infrastructure businesses' risk profiles.

TICCS 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.

Any infrastructure investment ultimately corresponds to shares (or quasi-equity) invested in a company or debt instruments issued by a company (or borrower). TICCS is a taxonomy designed to classify and organize data about equity and debt investments in infrastructure companies.

TICCS is a class-based taxonomy consisting of four pillars:

1. Business risk (divided into BR classes)

2. Industrial activity (IC classes)

3. Geo-economic exposure (GE classes)

4. Corporate governance (CG classes).

Each of these is made of non-overlapping super-classes, classes, and sub-classes of pure characteristics.

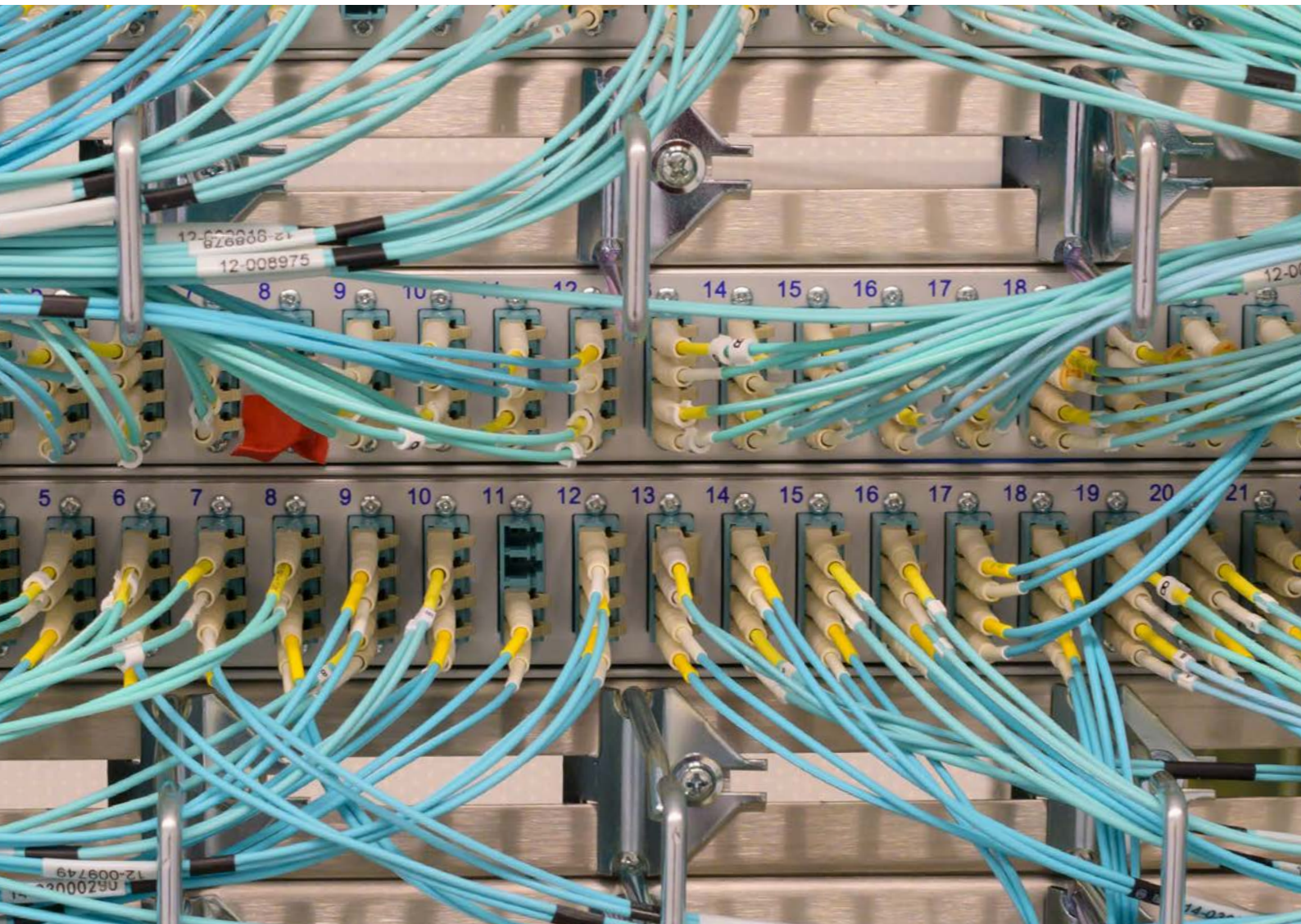
Real-life infrastructure companies always belong to each individual pillar and may also fall into multiple classes within each pillar (e.g., an infrastructure project company may own both a water treatment plant and a power generation asset).

TICCS is also about risk; however, it is not designed to discriminate between pure sources of systematic risks in infrastructure companies. Rather, as a taxonomy of infrastructure companies, TICCS aims to be an exhaustive list of objective, real-world, distinguishing characteristics (i.e., a system to organize information about actual firms).

Each TICCS pillar captures a different dimension of what makes infrastructure companies both unique and relatively more homogenous. In that sense, the TICCS pillars capture differences in aggregate risk profile that represent combinations of systematic risk factors, even though these are not the object of the taxonomy.

Appendix 2

Peer Group Styles



Appendix 2.1 - Peer Group by Industrial Activity

Peer Group		Power Generation x-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	79	2.4%	4.2%	15.2%	10.4%	7.9%	17.1%	35.7%	7.1%
Asset Owners	280	1.3%	4.2%	11.1%	18.6%	7.6%	22.6%	24.3%	10.4%
Investors Home									
Australia-New Zealand Investors	56	1.4%	6.4%	19.2%	10.7%	6.7%	39.8%	8.6%	7.3%
North American Investors	246	2.9%	4.9%	6.9%	23.2%	7.1%	20.6%	24.4%	9.9%
Canadian Investors	32	0.8%	3.3%	21.0%	14.3%	10.5%	19.7%	22.3%	8.2%
EU Investors	190	1.0%	3.6%	15.3%	8.9%	8.0%	30.3%	29.9%	3.1%
UK Investors	134	1.5%	3.0%	30.0%	9.0%	5.8%	17.7%	26.7%	6.2%
US Investors	185	9.4%	4.9%	2.8%	26.7%	6.1%	19.7%	25.1%	5.2%
Rest of the World Investors	100	6.8%	5.2%	7.0%	7.7%	5.6%	38.1%	21.9%	7.8%
Asset Manager Styles									
Infrastructure Asset Managers	84	1.0%	5.8%	19.5%	9.5%	6.7%	16.0%	36.2%	5.2%
Multi-asset Managers	33	2.8%	2.8%	11.6%	12.3%	8.8%	19.1%	36.1%	6.5%
Asset Owner Styles									
European Pension Funds	30	1.2%	3.5%	20.0%	12.7%	8.4%	21.1%	27.1%	6.2%
Global Insurers	54	0.4%	2.9%	5.5%	17.0%	12.7%	22.0%	29.7%	9.7%
North American Pension Funds	63	1.5%	4.9%	4.2%	30.1%	6.9%	20.4%	22.9%	9.1%
Superannuation Funds	26	0.4%	7.5%	19.2%	10.1%	5.6%	37.8%	10.0%	9.3%
Sovereign Wealth Funds	12	5.0%	2.2%	14.8%	18.0%	7.5%	21.1%	27.3%	4.2%
Segment 10-year Total Return Volatility		**8.3%**	**9.4%**	**11.4%**	**16.5%**	**11.4%**	**14.3%**	**10.9%**	**13.0%**

Source: EDHECinfra & BCG Survey, infraMetrics® 2022.

Appendix 2.2 - Peer Group Investments by Business Model

Peer Group	Nr of peers	Contracted	Merchant	Regulated
TICCS® Code		BM10	BM20	BM30
Global Peer Groups				
Asset Managers	69	57.0%	18.6%	24.4%
Asset Owners	70	41.9%	25.2%	32.9%
Investors Home				
Australia-New Zealand investors	24	34.4%	32.2%	33.4%
North American Investors	38	50.7%	22.5%	26.8%
Canadian Investors	18	58.2%	18.0%	23.8%
EU Investors	28	56.7%	17.1%	26.3%
UK Investors	18	70.7%	9.6%	19.7%
US Investors	14	41.8%	26.0%	32.2%
Rest of the World Investors	18	28.9%	27.7%	43.5%
Asset Manager Styles				
Infrastructure Asset Managers	17	65.0%	18.1%	16.9%
Multi-asset Managers	26	55.5%	15.9%	28.6%
Asset Owner Styles				
European Pension Funds	13	58.8%	12.0%	29.2%
Global Insurers	34	46.7%	23.1%	30.3%
North American Pension Funds	13	43.4%	31.4%	25.2%
Superannuation Funds	15	32.7%	34.8%	32.5%
Sovereign Wealth Funds	10	35.3%	29.4%	35.3%
Segment 10-year Total Return Volatility		**10.8%**	**13.9%**	**13.2%**

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.3 - Peer Group Investments by Corporate Governance

Peer Group	Nr of peers	Project Finance	Corporate
TICCS® Code		CG10	CG20
Global Peer Groups			
Asset Managers	69	75.3%	24.7%
Asset Owners	70	61.3%	38.7%
Investors Home			
Australia-New Zealand Investors	24	51.8%	48.2%
North American Investors	38	74.3%	25.7%
Canadian Investors	18	73.8%	26.2%
EU Investors	28	71.9%	28.1%
UK Investors	18	76.9%	23.1%
US Investors	14	71.9%	28.1%
Rest of the World Investors	18	56.2%	43.8%
Asset Manager Styles			
Infrastructure Asset Managers	17	77.3%	22.7%
Multi-asset Managers	26	76.1%	23.9%
Asset Owner Styles			
European Pension Funds	13	66.0%	34.0%
Global Insurers	34	48.8%	51.2%
North American Pension Funds	13	71.6%	28.4%
Superannuation Funds	15	54.0%	46.0%
Sovereign Wealth Funds	10	58.2%	41.8%
Segment 10-year Total Return Volatility		**11.4%**	**13.1%**

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.4 - Peer Group Investments by Region

Peer Group	Nr of peers	Africa	Asia	Australia	Europe	South America	Middle East	North America
Global Peer Groups								
Asset Managers	79	6.2%	2.5%	4.5%	60.3%	5.4%	0.2%	21.0%
Asset Owners	280	1.6%	4.9%	9.6%	46.2%	8.9%	0.3%	28.6%
Investors Home								
Australia-New Zealand Investors	56	0.1%	3.4%	59.0%	22.7%	2.0%	0.2%	12.5%
North American Investors	246	1.1%	4.2%	1.6%	26.0%	15.3%	0.4%	51.5%
Canadian Investors	32	0.1%	4.8%	4.5%	34.5%	5.8%	0.1%	50.1%
EU Investors	190	2.6%	2.0%	1.1%	81.9%	3.9%	0.6%	7.8%
UK Investors	134	1.2%	1.9%	1.9%	85.0%	2.4%	0.3%	7.3%
US Investors	185	1.4%	5.1%	2.0%	24.4%	10.2%	0.5%	56.3%
Rest of the World Investors	100	9.1%	23.9%	2.5%	18.3%	36.9%	2.8%	6.5%
Asset Manager Styles								
Infrastructure Asset Managers	84	3.6%	2.2%	4.0%	64.7%	4.6%	0.1%	20.8%
Multi-asset Managers	33	6.8%	2.8%	4.1%	60.2%	5.6%	0.3%	20.2%
Asset Owner Styles								
European Pension Funds	30	0.5%	1.7%	1.5%	79.5%	2.6%	0.1%	13.9%
Global Insurers	54	3.5%	6.3%	5.7%	59.4%	3.9%	0.6%	20.6%
North American Pension Funds	63	1.1%	5.6%	2.6%	29.3%	10.4%	0.3%	50.7%
Superannuation Funds	26	0.0%	5.0%	63.0%	23.1%	0.9%	0.0%	7.9%
Sovereign Wealth Funds	12	2.3%	10.8%	7.8%	52.4%	7.3%	5.1%	14.4%

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.5 - One-Year Total Return Contributions by Industrial Activity, Basis Points

Peer Group	Power Generation x-Renewables	Environmental Services	Social Infrastructure	Energy and Water Resources	Data Infrastructure	Transport	Renewable Power	Network Utilities	Total 1y Return
TICCS® Code	IC10	IC20	IC30	IC40	IC50	IC60	IC70	IC80	
Global Peer Groups									
Asset Owners	39	–53	65	257	51	482	136	110	1,086
Asset Manager	77	–52	89	158	50	278	137	107	844
Investors Home									
U.S. Investors	352	–62	17	472	45	334	149	95	1,402
North American Investors	99	–63	41	478	57	353	110	139	1,212
Australia-New Zealand investors	46	–83	113	88	58	908	78	78	1,285
Rest of the World Investors	250	–66	42	40	30	672	171	64	1,204
Canadian Investors	25	–40	122	253	70	298	102	120	950
European Union Investors	29	–44	90	115	37	424	129	69	850
United Kingdom Investors	45	–36	175	135	23	194	94	104	734
Asset Manager Styles									
Multi-asset Managers	95	–33	68	202	54	228	155	105	874
Infrastructure Asset Managers	27	–76	114	143	41	304	111	99	764
Asset Owner Styles									
North American Pension Funds	50	–63	25	621	69	496	104	134	1,436
Sovereign Wealth Funds	181	–24	87	175	48	500	197	71	1,233
Superannuation Funds	13	–99	113	74	68	920	88	84	1,261
Global Insurers	14	–35	32	198	43	499	129	99	980
European Pension Funds	34	–42	117	163	30	284	125	88	798

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.6 - One-Year Total Return Contributions by Business Risk Style, Basis Points

Peer Group	Contracted	Merchant	Regulated	Total 1y return
TICCS® Code	BM10	BM20	BM30	
Global Peer Groups				
Asset Owners	285	588	213	1086
Asset Manager	262	422	160	844
Investors Home				
U.S. Investors	530	665	208	1402
North American Investors	536	530	146	1212
Australia-New Zealand Investors	113	912	260	1285
Rest of the World Investors	94	774	335	1204
Canadian Investors	391	426	134	950
European Union Investors	230	424	196	850
United Kingdom Investors	382	223	129	734
Asset Manager Styles				
Multi-asset Managers	322	373	179	874
Infrastructure Asset Managers	259	389	115	764
Asset Owner Styles				
North American Pension Funds	617	660	160	1436
Sovereign Wealth Funds	226	725	282	1233
Superannuation Funds	77	957	227	1261
Global Insurers	191	578	211	980
European Pension Funds	290	287	221	798

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.7 - One-Year Total Return Contributions by Corporate Governance Style, Basis Points

Peer Group	Project Finance	Corporate	Total 1y return
TICCS® Code	CG10	CG20	
Global Peer Groups			
Asset Owners	670	416	1,086
Asset Manager	618	226	844
Investors Home			
U.S. Investors	1,130	272	1,402
North American Investors	1,024	187	1,212
Australia-New Zealand Investors	427	858	1,285
Rest of the World Investors	505	698	1,204
Canadian Investors	768	182	950
European Union Investors	503	347	850
United Kingdom Investors	505	229	734
Asset Manager Styles			
Multi-asset Managers	687	187	874
Infrastructure Asset Managers	515	248	764
Asset Owner Styles			
North American Pension Funds	1,193	243	1,436
Sovereign Wealth Funds	628	605	1,233
Superannuation Funds	440	821	1,261
Global Insurers	420	559	980
European Pension Funds	448	350	798

Source: EDHECinfra, infraMetrics® 2022.

Appendix 2.8 - 2021 Peer Group Investments by Core, Core+, and Opportunistic Styles

Peer Group	Core	Core+	Opportunistic
Global Peer Groups			
Asset Managers	52.9%	24.0%	23.1%
Asset Owners	43.2%	29.0%	27.8%
Investors Home			
Australia-New Zealand Investors	44.1%	29.6%	26.3%
North American Investors	43.6%	28.5%	27.9%
Canadian Investors	46.7%	28.2%	25.1%
EU Investors	55.1%	23.4%	21.5%
UK Investors	55.5%	27.8%	16.7%
US Investors	44.4%	25.4%	30.3%
Rest of the World Investors	49.5%	23.7%	26.8%
Asset Manager Styles			
Infrastructure Asset Managers	55.1%	24.6%	20.3%
Multi-asset Managers	53.5%	23.2%	23.4%
Asset Owner Styles			
European Pension Funds	53.4%	26.0%	20.5%
Global Insurers	43.4%	26.9%	29.8%
North American Pension Funds	38.2%	30.3%	31.5%
Superannuation Funds	42.9%	31.0%	26.1%
Sovereign Wealth Funds	45.9%	26.2%	27.9%

Source: EDHECinfra, infraMetrics® 2022.

About the Authors

Frederic Blanc-Brude is the CEO and founder of Scientific Infra, an EDHEC venture that provides index and analytics to infrastructure investors. You may contact him at frederic.blanc-brude@edhec.edu.

Bernhard Georgii is a principal in BCG's Munich office. He is a member of the firm's Principal Investors and Private Equity practice and focuses on work with infrastructure investors. You may contact him at georgii.bernhard@bcg.com.

Wilhelm Schmundt is a managing director and partner in the Munich office of Boston Consulting Group. He is the global sector lead for the firm's work with infrastructure investors. You may contact him at schmundt.wilhelm@bcg.com.

Abhishek Gupta is an associate director and head of product development at Scientific Infra, based in the EDHECinfra London office. You may contact him at abhishek.gupta@edhec.edu.

Thomas Bumberger is a principal in BCG's Munich office. He is a topic expert on digital infrastructure with a strong focus on fiber infrastructure. You may contact him at bumberger.thomas@bcg.com.

Leonard Lum is a senior analyst at the EDHEC Infrastructure Institute. He is part of the EDHECinfra data team based in the Singapore office. You may contact him at leonard.lum@edhec.edu.

Roman Friedrich is a managing director and partner in the firm's Düsseldorf office. He is the global lead for BCG's Technology, Media, and Telecommunications infrastructure initiative. You may contact him at friedrich.roman@bcg.com.

Maikel Wilms is a partner and director in BCG's Amsterdam office. He leads the firm's Center for Telco Network Excellence globally. You may contact him at wilms.maikel@bcg.com.

For Further Contact

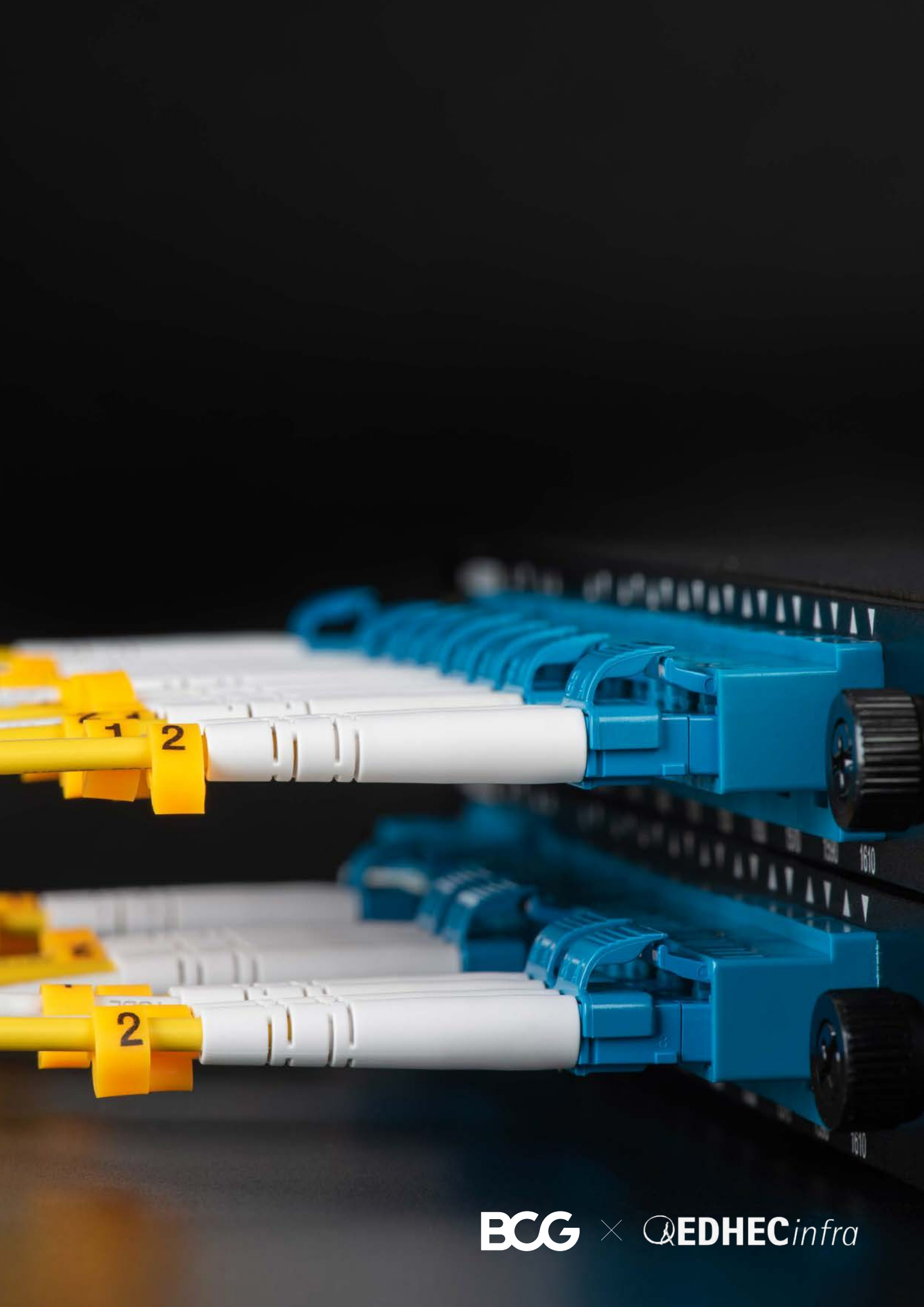
If you would like to discuss this report, please contact the authors.

For information or permission to reprint, please contact BCG at permissions@bcg.com.

To find the latest BCG content and register to receive e-alerts on this topic or others, please visit bcg.com.

Follow Boston Consulting Group on Facebook and Twitter.

© Boston Consulting Group 2022. All rights reserved.
3/22


BCG
EDHEC infra