

PUBLISHED BY | AUGUST 2024 | VOLUME 1 NUMBER 37 | A SUPPLEMENT TO PENSIONS & INVESTMENTS

P&I | CUSTOM  
CONTENT

# Research for Institutional Money Management

---

 **QEDHEC** Infra & Private Assets  
Research Institute



Scientific Infra  
& Private Assets  
An EDHEC Venture

# THE PULSE OF PRIVATE EQUITY MARKETS

## Asset-Level Private Equity Indices

The private2000 and private3000 market indices reflect the asset-level performance of private equity markets: the movements of private asset prices before fund managers add alpha.

<https://scientificinfra.com>

## INTRODUCTION

## Introduction to the Research for Institutional Money Management supplement in *Pensions & Investments*, August 2024

Frédéric Blanc-Brude  
Founding Director  
EDHEC Infra & Private Assets Research Institute

I am delighted to introduce the infrastructure investment special issue of the Institutional Money Management supplement to *Pensions & Investments*. Here we present the results of the EDHEC Infra & Private Assets Research Institute's most recent investigations with the aim of providing institutional investors with an academic research perspective on some of the most pressing issues facing them today.

Our first two articles delve into the field of environmental, social and governance risks, and the implications these hold for the investment community. In our first, we explore the practical challenges of using the EU Taxonomy for Sustainable Activities to assess the sustainability of the infrastructure asset class and conclude that, while the Taxonomy marks a significant step, it does not provide comprehensive insights. In the second, we develop Social Risk Sector Ratings and conduct a case study to examine how social acceptance on the sector level affects social risk levels for water companies in the UK. Significantly, our analysis shows that acceptance levels align with sector trends and reveals statistically significant relationships between sector sentiment and company support.

Our next two papers look at the investment implications of climate risk for global infrastructure. We first explore the substantial financial risks posed by climate change to infrastructure investments, which include both physical risks from extreme weather events and transition risks related to the shift towards greener technologies. We then present the findings of a survey of the international investment community which revealed that they are concerned and lack data regarding the physical climate risks overhanging the sector. These risks could be huge and could wipe as much as 54% off the value of portfolios and concerned investors say they have little confidence in the advice and data they are receiving.

Our final two articles present some of our latest research insights into infrastructure investment portfolio construction and risk management. The penultimate piece reveals how investors in Thames Water could have learned about the entity's risk and likely market value much earlier had they compared its characteristics to market and peer group data. A straightforward comparative analysis would have signaled a high-risk, low-return profile that should have raised numerous red flags. Our final paper looks at the challenging goal of achieving diversification in unlisted infrastructure investments, given their pronounced illiquidity. We show that a "Smart Infra" approach, focusing on diversifying factor risks, makes broad diversification feasible even given these hurdles.

We wish you an enjoyable read and extend our warmest thanks to P&I for their collaboration on the supplement.

## CONTENT

4

Using Taxonomies to Qualify  
the Sustainability of Infrastructure  
Investments

6

Social Risk Indexing and Rating  
for Infrastructure Investors:  
The Case of the UK Water Sector

11

Computing Extreme Climate Value  
for Infrastructure Investments:  
Asset Pricing Applied to NGFS  
Phase 4 and Oxford Economics  
Scenarios to Measuring Climate  
Risks at the Asset Level

14

Physical Climate Risk Survey:  
Those in the Infrastructure  
Investment Industry are  
Concerned and Lack Data

18

Low Tide: Benchmarking Risks  
in Infrastructure Investments:  
What the Data Showed about  
Thames Water

22

Achieving Diversification  
in Unlisted Infrastructure  
Investment: A Smart Infra  
Portfolio Construction

# contributors

Noël Amenc  
Director  
EDHEC Infra & Private Assets Research Institute  
Affiliate Member  
EDHEC-Risk Climate Impact Institute

Rob Arnold  
Sustainability Research Director  
EDHEC-Risk Climate Impact Institute

Frédéric Blanc-Brude  
Founding Director  
EDHEC Infra & Private Assets Research Institute

Moataz Farid  
Quantitative Analyst  
EDHEC Infra & Private Assets Research Institute

Abhishek Gupta  
Associate Director  
EDHEC Infra & Private Assets Research Institute

Alice James  
Writer  
EDHEC Infra & Private Assets Research Institute

Bertrand Jayles  
Senior Sustainability Data Scientist  
EDHEC Infra & Private Assets Research Institute

Nishtha Manocha  
Senior Research Engineer  
EDHEC Infra & Private Assets Research Institute

Jeanette Orminski  
Senior Sustainability & ESG Researcher  
EDHEC Infra & Private Assets Research Institute

Jianyong Shen  
Senior Research Engineer and Deputy Lead  
of Research & Development  
EDHEC Infra & Private Assets Research Institute

Tim Whittaker  
Research Director and Head of Data Collection  
EDHEC Infra & Private Assets Research Institute

# Using Taxonomies to Qualify the Sustainability of Infrastructure Investments

Nishtha Manocha  
Senior Research Engineer  
EDHEC Infra & Private Assets Research Institute

Rob Arnold  
Sustainability Research Director  
EDHEC-Risk Climate Impact Institute

- The EU Taxonomy is the first global effort to address environmental sustainability and to provide a robust framework for classifying economic activities based on their environmental impact.
- In this study, we explore the practical challenges of using the Taxonomy to assess the sustainability of the infrastructure asset class.
- We conclude that while it marks a significant step in identifying sustainable economic activities, it does not provide comprehensive insights for the infrastructure asset class.
- We recognize the need for deeper insights into asset-level actions and strategies that can bridge the gap between eligibility and alignment with the EU Taxonomy's sustainability criteria.

## INTRODUCTION

This study explores the practical challenges of using the EU Taxonomy for Sustainable Activities to assess the sustainability of the infrastructure asset class. It concludes that, while the EU Taxonomy marks a significant step in identifying sustainable economic activities, it does not provide comprehensive insights for the infrastructure asset class. By mapping the EU Taxonomy to the infrastructure asset class using TICCS®, we address how green taxonomies can be applied to infrastructure sustainability assessments. We also propose key improvements to enhance the applicability of such green taxonomies in identifying and promoting the transition to a low carbon economy.

We also use the suggested mapping as a framework to assess the sustainability of the European infrastructure asset class under the EU Taxonomy. We find that USD1.5 trillion of the European infrastructure asset class (in the European Economic Area and UK) by size is likely to qualify as sustainable under the EU Taxonomy, while about USD 20 billion of assets by size is likely to have no sustainable characteristics and could be stranded in the transition to a low-carbon economy. Additionally, more than USD215 billion of infrastructure is not aligned with the Taxonomy's current description of sustainability<sup>1</sup>.

## THE ROLE OF SUSTAINABLE TAXONOMIES

The EU Taxonomy is the first global effort to address environmental sustainability and to provide a robust framework for classifying economic activities based on their environmental impact. The primary objective of the EU Taxonomy is to assist investors in discerning sustainable investment opportunities while preventing the misrepresentation of sustainability. Furthermore, the EU Taxonomy seeks to streamline investments aimed at transitioning towards a sustainable, low-carbon economy. Consequently, it holds significant sway over the perception and strategic approach to assets within the European Union, including infrastructure assets and financial products based on them.

Classifying an infrastructure asset as sustainable is likely to confer several advantages on it. Sustainable investments qualify for public sector financial incentives, such as cash grants, soft loans, and tax incentives, as well as increased access to private sector loans that may have more favorable terms than the market standard.

A sustainable classification may also signify that the asset is aligned with long-term climate policy objectives that enable the transition to a low-carbon economy, thus making it attractive to long-term investors during the transition to a low-carbon economy.

Assets that fail to qualify as sustainable in the EU Taxonomy will be ineligible for participation in EU green finance programs. Ineligibility may arise from underlying technology or geographic location, an inability to shift away from greenhouse gas-emitting processes or difficulties in complying with regulatory requirements, hindering the collective transition to a low-carbon economy.

## A FRAMEWORK FOR USING THE EU TAXONOMY TO IDENTIFY SUSTAINABLE INFRASTRUCTURE INVESTMENTS

The EU Taxonomy is a classification system established by the EU to identify environmentally sustainable economic activities, supporting the region's transition to a greener and more sustainable economy. This framework presents a list of sustainable economic activities across various sectors, including infrastructure-related activities such as the generation of energy through bio-energy, geothermal sources, hydropower, and more.

Investors face a significant challenge when evaluating the eligibility and alignment of their investments with the EU Taxonomy, particularly at the individual company level. This is because the EU Taxonomy is structured as a list of activities and currently there is no framework that identifies the activities of an infrastructure company and subsequently maps it to those of the EU Taxonomy. Further, infrastructure companies have complex and diversified business operations which may engage in a mix of sustainable and unsustainable activities. For example, mapping the activities of a company in the transport or energy sector to the EU Taxonomy is a complex and challenging task. These sectors encompass a wide array of operations, from traditional fossil fuel-based activities to renewable energy generation, electric mobility, and sustainable transportation. The sheer diversity of activities within these sectors makes it difficult to isolate and categorize them accurately. Moreover, many companies in these sectors have interconnected processes that further complicate the classification. For instance, an energy company may

simultaneously operate conventional power plants and generate electricity from renewable sources.

This study addresses one of the most significant problems in this context: mapping the infrastructure asset class, classified by TICCS®, to the activities of the EU Taxonomy.

Currently, there are numerous large asset owners and asset managers using TICCS® for strategic asset allocation, portfolio construction and performance attribution. The mapping of TICCS® to the EU Taxonomy outlined in this paper serves as a valuable resource for these infrastructure investors, providing them with a systematic approach to understanding the sustainability and associated investment risks within their infrastructure portfolio. Using the TICCS® classification as a starting point, infrastructure investors can identify potential EU Taxonomy-eligible investments, positioning themselves a step ahead in meeting broader EU Taxonomy-aligned reporting requirements.

Taxonomy eligibility is an assessment of whether an economic activity has a set of corresponding criteria in the Taxonomy to be assessed against – in other words, whether the activity is in the scope of the Taxonomy to begin with. To be considered aligned, an economic activity must meet specific technical screening criteria showing that it contributes to at least one of the Taxonomy's six objectives and also "Do No Significant Harm" (DNSH) to any other objective; and meets the minimum safeguards. This study focuses on assessing only the eligibility of infrastructure subclasses to the EU Taxonomy.

## METHODOLOGY: MAPPING TICCS® TO THE EU TAXONOMY

The economic activities of the EU taxonomy are themselves derived using NACE as their basis. The European Commission maps the EU Taxonomy activities against the NACE classification system, and for each sustainable activity provides the corresponding NACE codes.

The first step in this exercise is to identify the primary activity of each infrastructure asset subclass and map it to the NACE classification system. This mapping focuses on the main activity rather than all possible activities of any given asset subclass. Considering the main activity instead of all sub-activities ensures that

<sup>1</sup> Visit [https://publishing.edhecinfra.com/papers/2023\\_taxonomies\\_sustainability\\_infrastructure\\_investments.pdf](https://publishing.edhecinfra.com/papers/2023_taxonomies_sustainability_infrastructure_investments.pdf) for a more in depth study of the topics discussed here.

the sustainability assessment is centered around the primary function of the asset.

Using the NACE codes associated with the main activity of an asset subclass as a bridge, we determine whether a TICCS® asset subclass was consistent with activities classified as sustainable within the EU Taxonomy, specifically focusing on the objectives of climate change mitigation and climate change adaptation. Through this process, we facilitated the mapping of TICCS® asset subclasses to the specific activities outlined in the EU Taxonomy, enabling a clear understanding of the sustainability eligibility of these subclasses.

The EU Taxonomy is a list of sustainable activities, but it is not a list of unsustainable ones i.e. not being in the list of the activities identified by the EU Taxonomy does not mean that these excluded activities and associated asset classes are unsustainable. The asset classes that are not eligible for the EU Taxonomy thus cover a range of assets from those that are unsustainable such as fossil fuel power plants, to those that are inherently green such as parks.

To get a clearer picture of the (in)eligibility of the infrastructure asset class with the EU taxonomy, an additional step of discretionary categorization was carried out in this study, wherein we re-classified the ineligible asset classes into:

- **Low-Carbon Assets:** These assets have minimal adverse sustainability impacts but are not explicitly classified as sustainable by the EU Taxonomy. Examples include public parks and gardens. These assets are re-classified as eligible.
- **Supporting Assets:** These assets support and facilitate sustainable activities but do not primarily align with EU Taxonomy criteria. Examples include infrastructure for natural gas distribution. These assets are classified as ineligible.
- **Potentially Stranded Assets:** Assets like coal and oil are at risk of devaluation due to evolving climate policies and market changes. Gas is considered eligible for transition activities. These assets are classified as ineligible.
- **Ambiguous Assets:** Assets with activities that might be sustainable but do not directly align with EU Taxonomy, such as social infrastructure implementing renewable energy systems. These assets are classified as ineligible.

The final mapping that categorizes each TICCS® asset subclass under the taxonomy is presented in the study.

#### CASE STUDY: HOW SUSTAINABLE IS THE EUROPEAN INFRASTRUCTURE ASSET CLASS?

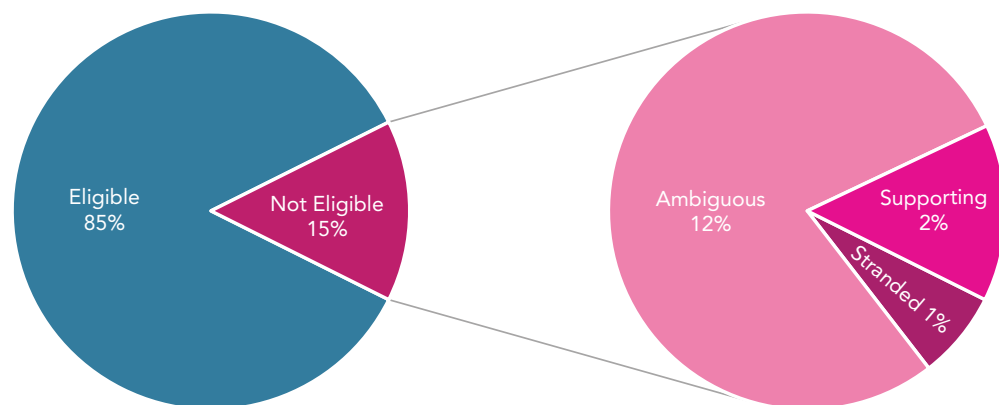
Using the mapping presented above, this study classifies about 5,300 companies of the EDHECinfra European universe (European Economic Area and the UK) as eligible or not under the activities listed as sustainable by the EU Taxonomy.

The 15% of companies that do not qualify as sustainable in this study constitute approximately USD275 billion worth of infrastructure investments in Europe. Among these, about USD20 billion of assets by size have no sustainable characteristics and would likely be stranded in the transition to a low-carbon economy. More than USD215 billion of infrastructure is not aligned with the EU Taxonomy's definition of sustainability as is. While these assets are not explicitly classified as sustainable and are categorized as unaligned to the EU taxonomy, they could potentially be decarbonized with technological interventions and in the future

FIGURE 1

#### Eligibility of EDHECinfra European Assets to the EU Taxonomy by asset value

Note: Eligible assets include both those initially designated as eligible and those that have been recategorized as low carbon assets.



could meet the requirements of the EU Taxonomy. The remaining USD40 billion assets do not explicitly align with the EU Taxonomy's definition of sustainability but have activities that support other eligible activities. This distribution is presented in Figure 1.

Notably, the power sector stands out as a substantial contributor to this high level of compliance. This phenomenon can be largely attributed to the substantial investments made in renewable energy assets across Europe driven by various incentives and regulations, such as the EU's Renewable Energy Directive.

In the development of the EU Taxonomy, there was considerable debate on the inclusion of nuclear and gas (classified as non-renewable power infrastructure in TICCS®) activities, reflecting the intricate task of balancing energy security and sustainability in energy mixes within EU member states. Key concerns centered on the sustainability of nuclear and gas, due to associated greenhouse gas emissions, and the management of radioactive waste. Despite objections from various stakeholders, including environmental groups and EU Parliament members, gas and nuclear were eventually added to the taxonomy as transition activities, acknowledging the absence of readily available low-carbon alternatives. This study finds that excluding gas and nuclear assets (gas and nuclear power plants and gas pipelines) led to a notable decline in eligible assets, from 85% to 80%, with approximately USD80 billion worth of assets becoming ineligible. The share of stranded assets increases significantly, from USD20 billion to USD100 billion. This underscores the taxonomy's sensitivity to technology inclusion/exclusion and emphasizes the crucial role of regulators in shaping sustainable infrastructure practices.

This study, by delineating the activities of each infrastructure industry subclass and identifying their overlap with the EU Taxonomy, contributes to the initial step of determining the eligibility of an investment to the EU Taxonomy. This step is crucial for infrastructure investors seeking to incorporate sustainability considerations into their portfolios, providing a foundation for further evaluation and decision-making.

#### THE WAY FORWARD

The categorization of an asset class as eligible to the EU Taxonomy, as demonstrated in this study, does

not make it automatically aligned with the taxonomy. The qualification merely signifies eligibility for further scrutiny against the "Substantial Contribution" and "Do No Significant Harm" criteria outlined by the EU Taxonomy.

While the study contributes to the initial step of determining eligibility by delineating the activities of each infrastructure industry subclass and identifying their overlap with the EU Taxonomy, it does not offer additional insights on how aligned eligible assets are or how can ineligible assets improve processes to improve their sustainability performance in the future. This result leaves investors without enough information on the risks they face when it comes to alignment (and resilience). For instance, if airports can, in principle, be green, what can a specific airport do in practice and how much will it cost? This highlights a knowledge gap that could potentially serve as a guide for the sustainability roadmap of any given infrastructure company.

The premise that alignment is possible is implicit in the taxonomy's structure. However, answering this question forms the basis for a more comprehensive investigation, recognizing the need for deeper insights into asset-level actions and strategies that can bridge the gap between eligibility and alignment with the EU Taxonomy's sustainability criteria. Addressing this knowledge gap is essential for understanding the practical steps and transitions required for aligning infrastructure assets with the objectives of initiatives like the EU Taxonomy. This knowledge will be instrumental both for asset owners to understand practical approaches to improving sustainability and for investors in identifying sustainable investments, guiding the allocation of funding and investments toward the goal of transitioning to a low-carbon economy, and facilitating the broader sustainability objectives.

A new research initiative at the EDHEC Infra & Private Assets Research Institute is building a body of knowledge on the most impactful asset-level strategies, their effectiveness, and associated costs, available to infrastructure assets to decarbonize and improve climate resilience. This intentional approach enables a focused examination of practical, asset-level interventions within the current technological landscape.

# Social Risk Indexing and Rating for Infrastructure Investors: The Case of the UK Water Sector

Jeanette Orminski  
Senior Sustainability & ESG Researcher  
EDHEC Infra & Private Assets Research Institute

- This article summarizes the findings of a new paper<sup>2</sup> in which we develop Social Risk Sector Ratings and conduct a case study to examine how social acceptance on the sector level affects social risk levels for water companies in the UK.
- We find that the private water sector in the UK suffers from a poor reputation, facing significant social and political backlash.
- Significantly, our analysis shows that acceptance levels align with sector trends and reveals statistically significant relationships between sector sentiment and company support.
- These findings illustrate the importance of understanding sector effects in managing social risks and highlight the varying degrees to which individual companies are influenced by sector-level sentiment.

## INTRODUCTION

Infrastructure investments have significant positive impacts on economies and societies, but they also pose real or perceived negative impacts. As a result, the social acceptance of infrastructure projects is material for investors and can create significant risks and consequences.

Recent examples highlight the challenges and consequences of social risks in infrastructure investments.

- In **the UK**, widespread protests against sewage spills by water companies led to regulatory changes in April 2023, removing the fine cap and more than doubling pollution fines for the first half of 2023 compared to 2022 (Segal, 2023).
- In **France**, a court ordered the dismantling of wind turbines near Montpellier following resident protests about noise and environmental concerns, including a study showing bird deaths (Jenkinson, 2023).
- In **the US**, landowners in Iowa leveraged the upcoming 2024 presidential election to block a carbon pipeline project to protect their property and agriculture industry (Frankel & Tabet, 2023).
- In **Germany**, coal-mining projects have always faced strong opposition and protests that required expensive clearances, increasing costs and delaying projects (DW, 2023).

These cases illustrate the dynamic relationship between infrastructure assets and societal reactions. Social risks can lead to project delays, increased costs, regulatory changes, and long-term reputational damage, making them financially material for companies. To manage these social risks, it is essential to identify which risks are controllable.

Social risks at the asset level comprise two components: The **systematic component** relates to the market, country, or sector and includes factors such as industry reputation, public perception, and regulations. This component can be assessed but not directly controlled by the investor. The **idiosyncratic component** is specific to the company or asset and can be influenced by actions that improve public perception.

In this research, we apply Natural Language Processing (NLP) techniques and sentiment analysis to measure the systematic part of social risk using news and social media data. Our results indicate that the systematic component accounts for 60–70% of total social risk. This means that only 30–40% of a company's social acceptance is directly controllable. Therefore, once an investor selects a market or sector, **more than half of the social risk is predetermined due to its systematic nature**. Asset and investment managers can use our systematic social risk assessments to a) estimate risks at the asset level and b) compare and manage social risks at the portfolio level.

## SOCIAL ACCEPTANCE INDICES

Social acceptance is a critical indicator of social impact and potential financial risks for infrastructure developers and investors. It involves understanding the factors that influence public support for different sectors to identify material risk factors.

Research around **social acceptance** is interdisciplinary and varies in definition. It describes the positive outcome of an acceptability process at a specific point in time, which means social acceptance can change as perceptions and circumstances evolve (Busse & Siebert, 2018). Wüstenhagen, Wolsink and Bürer (2007) categorize social acceptance into three types: socio-political acceptance (public approval of policies and new technologies), community acceptance (those directly affected by infrastructure siting decisions), and market acceptance (reflected in consumer demand and investment in new technologies and infrastructure). Achieving social acceptance requires aligning stakeholder interests and maintaining a social license to operate, an informal "social contract" granting consent for project development and operation (Vauban Infrastructure Partners, 2022). Without this, project costs and development times can increase, and projects can face delays or cancellations.

### Social Support Index

The Social Support Index measures the average level of public acceptance for specific infrastructure asset classes on a scale from 0 to 100, with 100 indicating full social support. This index combines sentiment from news coverage and social media discourse to provide insights into public support trends over time across different sectors and countries. By comparing sectors or countries and analyzing trends, investors can understand the public's acceptance levels and make informed decisions.

### Social Consensus Index

The Social Consensus Index assesses the level of agreement within the public by measuring sentiment polarization. This index ranges from 0 to 100, with higher values indicating greater consensus and stability in public acceptance. It captures the variance in sentiment scores to determine how unified or divided public opinion is regarding specific infrastructure projects. A higher consensus suggests more stable public acceptance and support (or lack thereof).

### Social Attention Trend

The Social Attention Trend tracks the focus on selected topics in news coverage and social media discussions. This metric highlights the proportion of ESG-related topics being covered, indicating which issues are becoming salient and thus potential material risk factors. Increased attention to a particular issue suggests that it is becoming more significant in public discourse, which can impact the social acceptance of related projects.<sup>3</sup>

<sup>2</sup> See [https://publishing.edhecinfra.com/papers/2024\\_Social\\_Risk\\_Indexing.pdf](https://publishing.edhecinfra.com/papers/2024_Social_Risk_Indexing.pdf) for the full paper.

<sup>3</sup> To identify the salient social impact and risk factors, we followed the ESG Taxonomy (Manocha, Marcelo and Blanc-Brude, 2022) to develop an ESG Dictionary (Orminski & Shen, 2023). This dictionary successfully detects 20 social impact and risk factors in textual data related to the general public (e.g., human health, pollution, socio-economic factors), customer service (quality, availability, and affordability of services), the workforce (e.g., working conditions, payment, safety, labor rights), and regulatory risks.

FIGURE 1

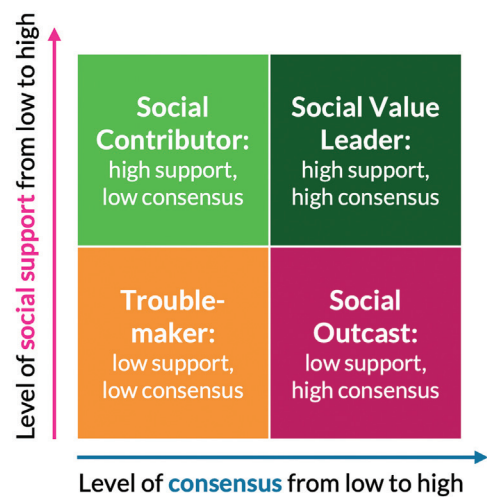
**Style boxes representing four types of sectors based on their level of social support and consensus**

**Social Value Leader:** Sectors with high support from most members of the public.

**Social Contributor:** Strongly supported but widely debated sectors.

**Troublemaker:** Unsupported and widely debated sectors.

**Social Outcast:** Sectors with low support from most members of the public.



We developed three social acceptance metrics to monitor impacts and risks across various infrastructure asset groups on a regional level, currently covering

- **23 sector groups** following *Scientific Infra's* TICCS® classification (Scientific Infra & Private Assets Research Institute, 2022)
- in **five countries** (US, UK, Canada, Australia, and New Zealand)
- over a period of **more than 10 years**.

The metrics provide valuable insights into public sentiment and potential risks, helping to navigate the complex landscape of infrastructure development and investment.

### SOCIAL RISK SECTOR RATING

*Scientific Infra's* Social Risk Sector Ratings analyze the relationship between the Social Support Index and the Social Consensus Index across various sector groups. These ratings are visualized using style boxes, which are divided based on the global cross-sector median values of the Social Support and Social Consensus indices from 2018 to 2023.

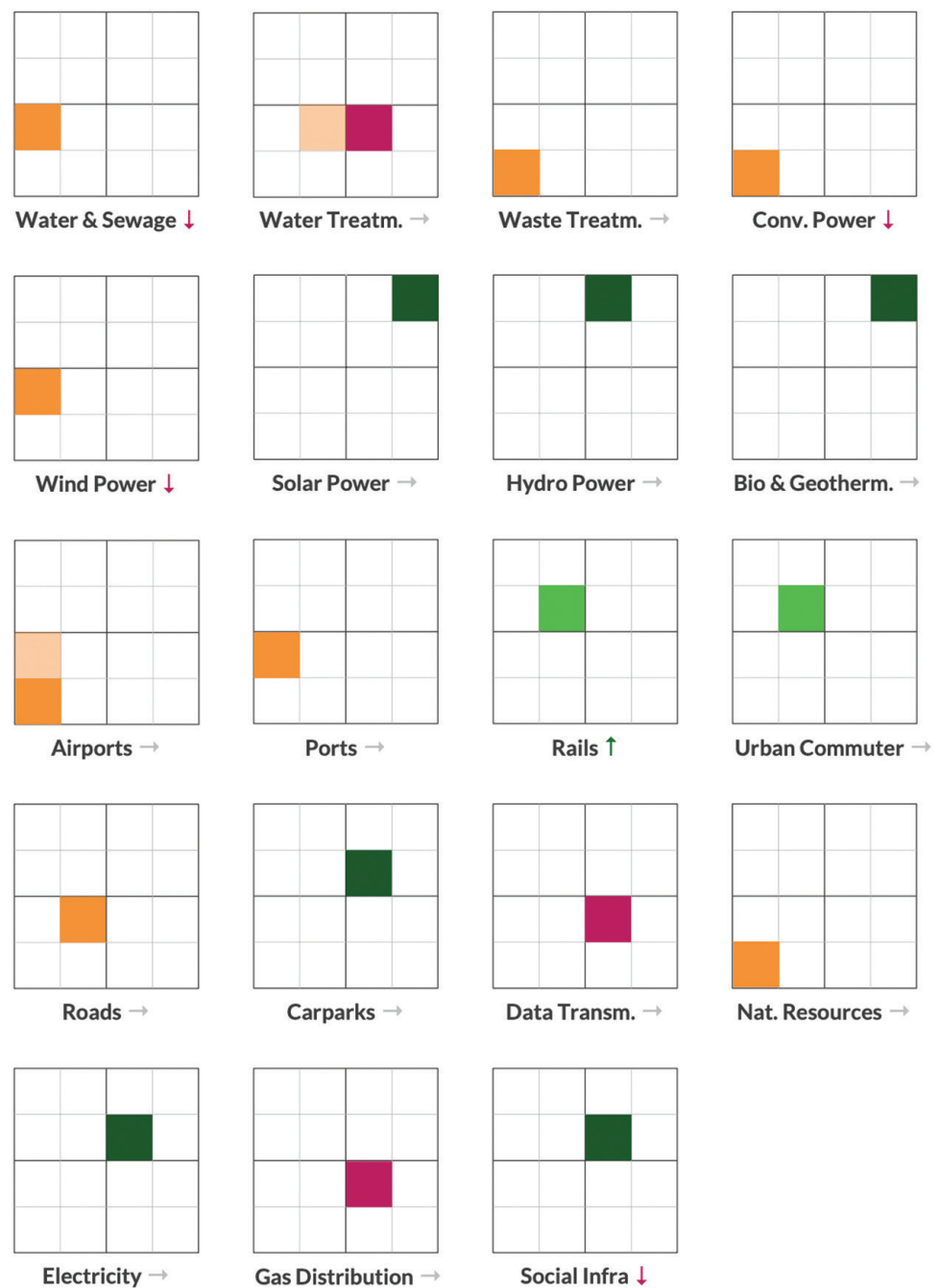
The style boxes categorize sectors into four quadrants, representing different levels of social acceptance and associated risks (see Figure 1):

To provide more detailed insights and track changes in social acceptance, the ratings focus on three specific results (see Figures 2 and Figure 3 for the global and UK ratings, respectively):

1. **Latest quarter:** The style boxes are split into quartiles of the Social Support and Social Consensus indices. The highlighted square shows the average social acceptance for the most recent quarter (Q3/2023).
2. **Yearly changes:** If a sector has shifted between quartiles over the past year, the style boxes highlight these changes with a lighter shade for the same quarter from the previous year (Q3/2022).
3. **Trend indicator:** A trend indicator shows the development of the Social Support Index compared to the same period a year ago, indicating whether support has increased ( $> +1\%$  ↑), decreased ( $< -1\%$  ↓), or

FIGURE 2

**Global Social Risk Sector Rating YE2023**



remained unchanged ( $-1\% > +1\%$  →). The trend indicator focuses solely on the level of support, not consensus.

The Social Risk Sector Ratings show that globally, climate-focused sectors like renewable energy are more respected than polluting ones. However, wind power is less favored due to environmental and noise concerns, except in the UK, where it enjoys robust support due to effective policies and geographical advantages. In contrast, the UK's transport sector, specifically rail and urban commuter services, faces dissatisfaction due to delays and high costs. Understanding these nuances helps investors align with socially accepted sectors, mitigate risks, and make informed decisions that align with societal values.

### USE CASE: THE WATER AND SEWAGE SECTOR IN THE UNITED KINGDOM

#### A sector becoming increasingly controversial

Since the Water Act of 1989 privatized the UK's water and sewage sector, the focus shifted from infrastructure development to efficiency, private investments, and service quality despite maintaining a monopolistic structure. The regulator *Ofwat* oversees the sector, but despite regulatory efforts, customer complaints and

rising water bills have persisted. While early privatization saw infrastructure and environmental improvements, controversy grew over high executive salaries and prioritizing dividends over long-term investments, leading to substantial debt since the 1990s.

Additionally, public support has plummeted due to the sector's failure to meet leakage targets and manage ageing infrastructure, exacerbated by frequent sewage overflows into rivers and seas, sometimes illegally. In 2023, following major public protests, the regulator removed the £250,000 fine cap, significantly increasing pollution fines (Plimmer, 2023).

Despite water companies' pledges to invest £10 billion in infrastructure, environmentalists and customers fearing higher bills remain skeptical. The situation has reignited discussions on renationalization to ensure stable prices and transparency, with some advocating for the government's reacquisition of water services.

#### What do the social acceptance indices reveal?

The above review reveals that the private water sector in the UK suffers from a poor reputation, facing significant social and political backlash. The social acceptance indices show a steep decline in public support for the UK's water and sewage sector since 2020, reaching a new low by July 2023 (see Figure 4).

FIGURE 3

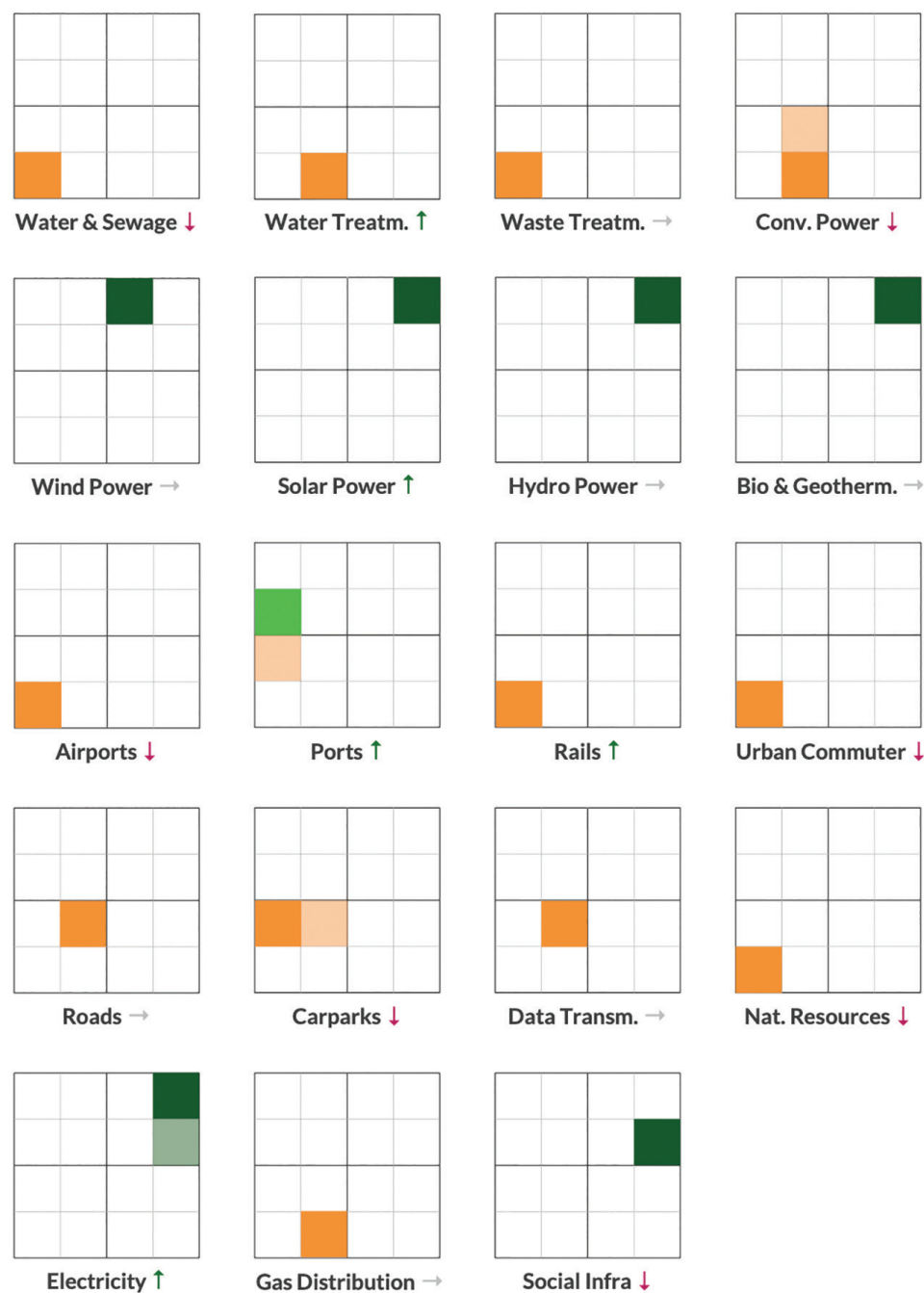
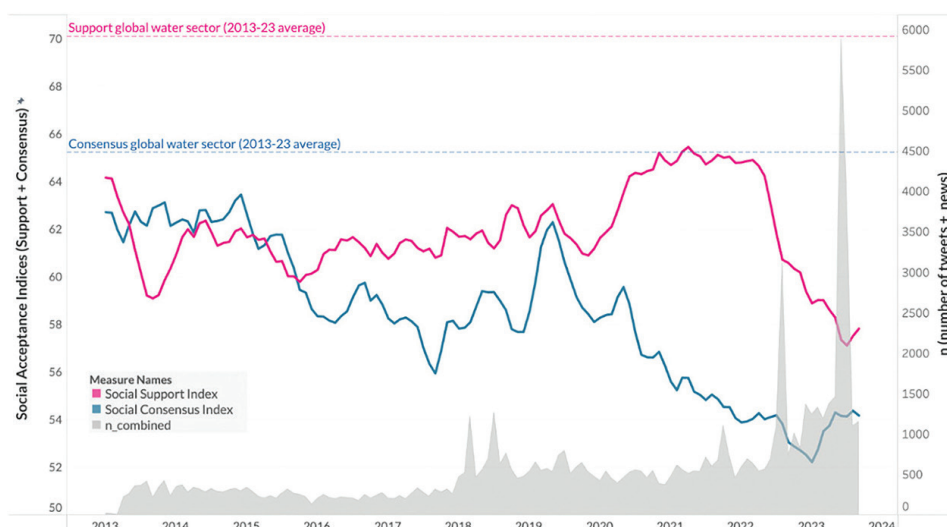
**The UK Social Risk Sector Rating YE2023**

FIGURE 4

**The Social Support Index (pink line) and the Social Consensus Index (blue line) for the UK water sector**

Notes: The left axis represents the Social Support and the Social Consensus indices in comparison to the global water sector (dotted lines). The right axis provides the number of tweets and news articles for each month (grey area).



This support level is significantly lower than the sector's global average (pink dotted line in Figure 4) as well as the average support for other infrastructure sectors within the UK.

Public discourse around the UK water sector remains slightly polarized, with increased opposing discussions between 2019 and 2023, for example, on issues like public vs. private ownership. However, the latest sewage scandal and its impact on the environment and human health led to a more aligned public discourse, with people agreeing on the low support. Overall, news coverage tends to show higher consensus on environmental issues, while discussions on social media are more polarizing, particularly regarding ownership debates.

Public dissatisfaction, combined with high consensus, can trigger regulatory risks. Low social support likely prompted the UK government to remove the pollution fine cap in April 2023, leading to higher fines and increased pressure on water companies. Continuous low support could further push discussions on renationalization. Understanding the social factors behind these sentiments is crucial for a full risk assessment.

**How do the sector results affect individual companies?**

To further understand the implications of sector-level social acceptance on individual companies, we examined how these sector-level results translate into social risk factors at the company level. Accordingly, we explored the social acceptance indices for specific companies to gain insights into the systematic component of social support. We compared *Thames Water*, *Southern Water*, and *Dwr Cymru Water*, all private monopolies in their regions, to see how sector-level support (or the lack thereof) affects them.

Our analysis shows that acceptance levels of these companies align with sector trends (see Figure 5). Furthermore, regression analyses reveal statistically significant relationships between sector sentiment and company support, with coefficients ranging from 0.26 to 1.24, indicating varying impacts (see Table 1).

**Southern Water** (red line in Figure 5) experienced a sharp decline in support following a £90 million fine for premature wastewater spills, resulting in the lowest support among UK water companies. Its coefficient of 0.26 (the lowest across all companies) suggests a modest yet significant relationship between sector- and company-level sentiment, highlighting the potential for improving its idiosyncratic component independently.

**Dwr Cymru Water** (green line in Figure 5), a not-for-profit company, enjoys the highest support due to its unique structure and the reinvesting of profits for public benefit, despite sharp declines in support during 2017–2018 and recent challenges. In contrast to Southern Water, its coefficient of 1.24 shows a strong correlation with sector-level social support, indicating limited control over social support levels.

**Thames Water** (blue line in Figure 5), the UK's largest water company, consistently shows the lowest support. Financial concerns, legal issues, and significant debt contribute to its vulnerable state. Its coefficient of 0.68 suggests a moderate impact of sector sentiment on the company's support level.

These findings illustrate the importance of understanding sector effects in managing social risks and highlight the varying degrees to which individual companies are influenced by sector-level sentiment. The UK water sector's issues with pollution, transparency, and financial mismanagement highlight the importance of managing systemic social risks within ESG frameworks. Approximately 70% of these risks are beyond direct control but can be managed within investment decisions. Understanding and monitoring public sentiment can help anticipate regulatory changes and manage social risks. The ongoing dissatisfaction among consumers, coupled with potential government actions like renationalization, underscores the critical link between social acceptance, financial materiality, and public policy.



## METHODOLOGY

### Where is the data coming from?

The data is sourced from two types of data: 1) local and international news articles provide insights into public concerns, and 2) the social media discourse on X (formerly Twitter) reflects people's unfiltered opinions. Both data sources are filtered for English-language content related to various infrastructure sectors and ESG topics according to Scientific Infra's TICCS and ESG Dictionaries (Orminski & Shen, 2023). The sentiment from these articles and tweets is used to gauge public social acceptance.

### How do you measure sentiment?

Sentiment in news articles and social media discourse is measured using a lexicographic approach, applying the VADER dictionary (Hutto & Gilbert, 2014). The dictionary classifies words as positive, neutral, or negative and assigns a polarity score from -1 to +1. The VADER dictionary is particularly suited for social media data. Accordingly, we added an additional step for news articles building a "Ground Truth" dataset to improve the accuracy of our analysis (Shen & Whittaker, 2023).

### Are your results valid?

The validity of the Social Support Index was tested against other public opinion measures, especially in the US and the UK, using representative panel surveys. Although the Social Support Index may show different levels compared to survey results, both sources follow the same trend (for more details, see Orminski & Shen, 2023). This alignment indicates that the Social Support Index provides a valid representation of public support.

More details on our methodology and all results of the Social Risk Rating can be found in the [full paper](#).

TABLE 1

### Effect of the UK water sector on the social acceptance of three UK water companies

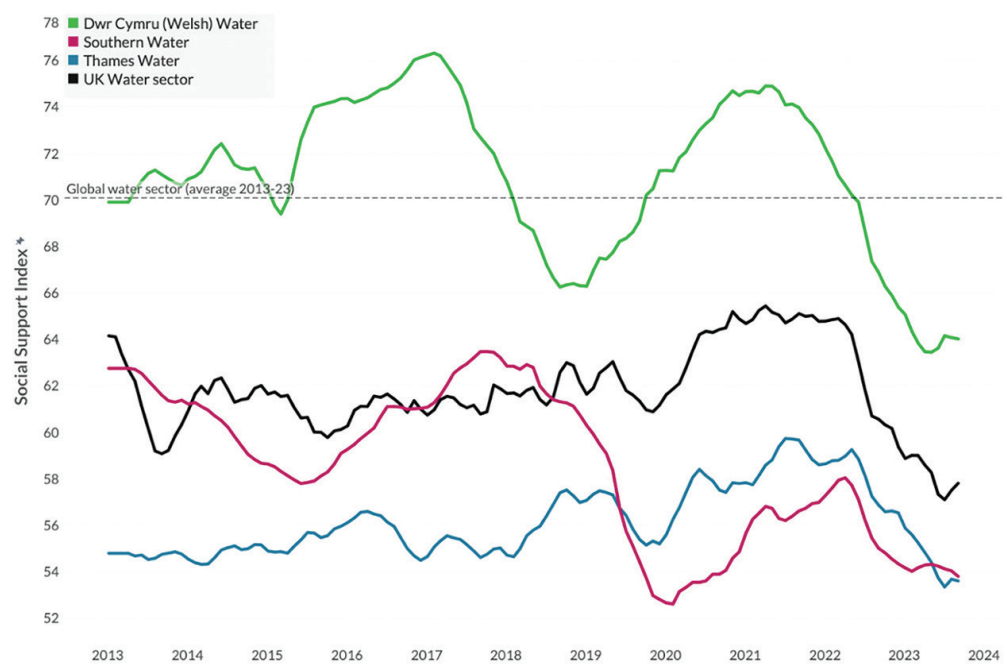
Note: Standard errors in parentheses. \*\*p<.001, \*p<.01.

Variables	Thames	Southern	Welsh
UK water sector	0.678** (0.037)	0.265* (0.095)	1.236** (0.059)
Constant	1.242** (0.154)	2.940** (0.394)	-0.867** (0.244)
Observations	68	68	68
R <sup>2</sup>	0.778	0.036	0.774

FIGURE 5

### Acceptance levels of these companies align with sector trends

Notes: The chart shows the Social Support Index for the UK water sector (black line) in comparison to the support for Dwr Cymru (Welsh) Water (green line), Southern Water (red line), and Thames Water (blue line).



## REFERENCES

- Busse, M. and R. Siebert (2018). Acceptance studies in the field of land use—A critical and systematic review to advance the conceptualization of acceptance and acceptability. *Land Use Policy*, 76, 235–245.
- DW (February, 2023). Germany: Lützerath anti-coal activists brace for clearance. *Deutsche Welle*. <https://www.dw.com/en/germany-l%C3%BCtzerath-anti-coal-activists-brace-for-clearance/a-64262667>.
- Frankel, J. and A. Tabet (September, 2023). A local struggle over carbon pipelines in Iowa is becoming a 2024 presidential flashpoint. *NBC News*. <https://www.nbcnews.com/politics/2024-election/local-struggle-carbon-pipelines-iowa-becoming-2024-presidential-flashp-rcna105198>.
- Hutto, C. and E. Gilbert (2014). VADER: A parsimonious rule-based model for sentiment analysis of social media text. *Proceedings of the International AAAI Conference on Web and Social Media*, 8(1), 216–225.
- Jenkinson, O. (December, 2023). Court orders dismantling of French wind farm over bird deaths. *Windpower Monthly*. <https://www.windpowermonthly.com/article/1851391/court-orders-dismantling-french-wind-farm-bird-deaths>.
- Manocha, N., D. Marcelo, and F. Blanc-Brude (July, 2022). *ESG Taxonomy of Impacts and Risks for Infrastructure Companies. Version 2.0*. Scientific Infra & Private Assets Research Institute Publication.
- Orminski, J. and J. Shen (June, 2023). *Social acceptance analysis using social media. Using Twitter data to measure sentiment about infrastructure sectors on the example of wind power generation*. Scientific Infra & Private Assets Research Institute Publication.
- Plimmer, G. (May, 2023). UK water industry pledges £10bn investment to stem sewage spills. *Financial Times*. <https://www.ft.com/content/ca9efe66-6675-41f4-9150-e0c3022c1c52>.
- Scientific Infra & Private Assets Research Institute (May, 2022). *The Infrastructure Company Classification Standard (TICCS®) 2022 Edition – includes NACE, EU Taxonomy and CPRS Mappings*.
- Segal, M. (December, 2023). UK eliminates cap on penalties on polluting companies. *ESG Today*. <https://www.esgtoday.com/uk-eliminates-cap-on-penalties-on-polluting-companies>.
- Shen, J. and T. Whittaker (February, 2023). *Measuring the social acceptability of infrastructure investments. A natural language processing approach*. Scientific Infra & Private Assets Research Institute Publication.
- Vauban Infrastructure Partners (2022). *Social license to invest, social license to operate. How to secure and leverage stakeholder engagement for infrastructure in 2022*. Technical report.
- Wüstenhagen, R., M. Wolsink, and M. J. Bürer (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, 35, 2683–2691.

# ANCHORING PRIVATE ASSET PRICES

Private Equity Valuations  
Updated Monthly

privateMetrics valuation data is the most robust starting point to gauge the level of private company prices. Calibrated with the latest market data, our multiples are both robust and granular.

# Computing Extreme Climate Value for Infrastructure Investments: Asset Pricing Applied to NGFS Phase 4 and Oxford Economics Scenarios to Measuring Climate Risks at the Asset Level

Bertrand Jayles

Senior Sustainability Data Scientist  
EDHEC Infra & Private Assets Research Institute

Jianyong Shen

Senior Research Engineer and Deputy Lead Research & Development  
EDHEC Infra & Private Assets Research Institute

- The research paper, “*Computing Extreme Climate Value for Infrastructure Investments*”<sup>4</sup> explores the substantial financial risks posed by climate change to infrastructure investments.
- These risks include both physical risks from extreme weather events and transition risks related to the shift towards greener technologies.
- The paper introduces a novel methodology to estimate these risks using economic and climate scenarios developed by the Network for Greening the Financial System (NGFS) and Oxford Economics.
- By incorporating financial and macroeconomic variables to project future cash flows and discount rates, the methodology provides a comprehensive tool for assessing climate risks in infrastructure investments.

## INTRODUCTION TO CLIMATE RISKS IN INFRASTRUCTURE

Infrastructure assets are essential to the functioning of modern society, providing critical services such as transportation, energy, water, and communication. These assets are designed to endure specific climate conditions but are now facing increased vulnerability due to climate change. The impact of climate change on infrastructure is multifaceted, involving both immediate and long-term consequences.

Extreme weather events, such as floods, hurricanes, heatwaves, and wildfires, pose direct physical risks to infrastructure. These events can cause substantial damage, leading to immediate financial losses and necessitating costly repairs and maintenance. For instance, the severe flooding in North-eastern Italy in 2023 resulted in extensive damage and high repair costs, highlighting the financial burden of such events on infrastructure investments.

Beyond physical damage, climate change also introduces transition risks. These risks are associated with the economic and regulatory changes required to shift towards a low-carbon economy. Transition risks include costs related to compliance with new regulations, investments in cleaner technologies, and potential changes in market demand. As governments and organizations worldwide implement policies to mitigate climate change, infrastructure investments must adapt to these evolving conditions.

## INSTITUTIONAL EFFORTS TO MANAGE CLIMATE RISKS

Recognizing the importance of addressing climate risks, several organizations have developed tools and frameworks to help financial institutions manage climate-related financial risks. One of the key initiatives in this area is the NGFS, established in 2017 by a group of central banks and supervisors. The NGFS has created a set of climate scenarios designed to assist financial institutions in evaluating and managing climate risks. These scenarios provide plausible future pathways,

incorporating various climate mitigation strategies and their potential economic impacts.

Building on the foundation laid by NGFS, Oxford Economics has developed additional climate scenarios that complement the NGFS scenarios. These scenarios enhance the robustness of climate risk assessments by addressing some limitations in the NGFS scenarios and offering a broader range of potential future outcomes. By combining the insights from NGFS and Oxford Economics, the paper presents a comprehensive approach to understanding and managing climate risks in infrastructure investments.

## METHODOLOGY FOR ESTIMATING CLIMATE RISKS

The paper’s proposed methodology employs a Discounted Cash Flow (DCF) approach to estimate the value of infrastructure companies under different climate scenarios. The DCF approach is widely used in financial analysis to value investments by projecting future cash flows and discounting them to present value. It is particularly suitable for long-term investments like infrastructure, where future cash flows can be significantly impacted by climate change.

The model integrates financial and macroeconomic data to project future cash flows and discount rates. Key financial variables include the revenues and size of the business. They are influenced by macroeconomic variables such as GDP, inflation and interest rates, which capture the broader economic impacts of climate change. Climate-related factors such as carbon pricing, regulatory compliance costs (carbon taxes), and physical damage also have a direct impact of cash flows.

Our cash flow models are based on historical from a broad sample of infrastructure companies across more than 20 countries worldwide and all sectors as defined per TICCS. In addition to historical financial data, the model incorporates data on carbon emissions and physical risks. Carbon emissions data is essential for understanding the exposure of infrastructure companies to transition risks, as policies aimed at reducing emissions can significantly

impact their operations. Physical risk data, on the other hand, helps to quantify the direct impact of extreme weather events on infrastructure assets. By integrating both types of data, the model provides a comprehensive assessment of climate risks. Figure 1 illustrates and summarizes the climate risk model.

## CLIMATE SCENARIOS AND THEIR IMPLICATIONS

Climate scenarios are critical for understanding the potential future impacts of climate change on infrastructure investments. These scenarios provide insights into how different pathways of climate change might affect economic and financial variables. The NGFS scenarios, widely used in the financial industry, offer plausible future macroeconomic and climate pathways. These scenarios include various climate mitigation strategies, ranging from aggressive action to limited or no action, and their corresponding economic impacts.

Oxford Economics scenarios complement the NGFS scenarios by providing additional perspectives and addressing some limitations. In particular, the NGFS scenarios seem overly optimistic regarding the reduction of carbon emissions in coming years (all scenarios but one reach negative emissions before 2050 in the Remind-Maggie integrated assessment model) and regarding the economic impact of a rise in mean temperature (GDP grows almost at the same pace in all scenarios). By contrast, Oxford Economics offers scenarios where countries fail to reduce their emissions and thereby to mitigate climate change. As a consequence, physical risks in these scenarios have a very material impact on the economy before 2050, which sounds like a more realistic “business-as-usual” case. These scenarios enhance the robustness of the analysis by offering a broader range of potential future outcomes. By combining insights from both sets of scenarios, the paper presents a comprehensive view of the possible impacts of climate change on infrastructure investments.

Despite their importance in assessing the impact of climate change on the financial sector, current climate scenarios have limitations that hinder their

<sup>4</sup> See [https://publishing.edhecinfra.com/papers/2024\\_computing\\_extreme\\_climate\\_value\\_for\\_infra\\_investments\\_research\\_paper.pdf](https://publishing.edhecinfra.com/papers/2024_computing_extreme_climate_value_for_infra_investments_research_paper.pdf).

practical utility. The primary limitation is the inability to assign probabilities to these scenarios. Since they are based on a limited number of narratives without measures of uncertainty or likelihood, it can lead to the incorrect perception that these scenarios represent the most likely futures or that all scenarios are equally probable. Additionally, relying on just a few scenarios with potentially questionable assumptions is somewhat restrictive. However, despite these drawbacks, climate scenarios still provide a valuable basis for estimating climate-related risks for both academia and the financial industry.

In the financial analysis of climate risks that follows, we retain three scenarios from NGFS and Oxford Economics (each), one from each scenario category:

- **Orderly Transition** scenario: the world starts aligning immediately with the Paris Agreement in order to mitigate climate change without abrupt transition shocks.
- **Disorderly Transition** scenario: the world starts aligning in the next decade (2030), thereby applying heavy tax shocks but still mitigating climate change.
- **No Transition** scenario: no actions are taken to mitigate climate change; the climate thus becomes much wilder.

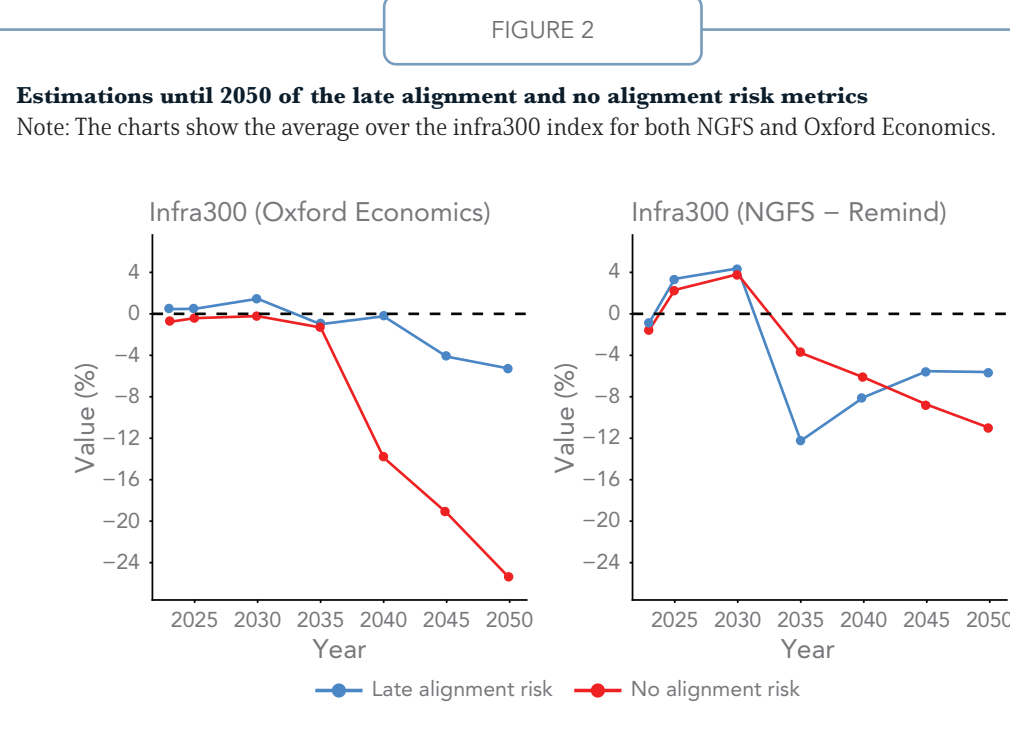
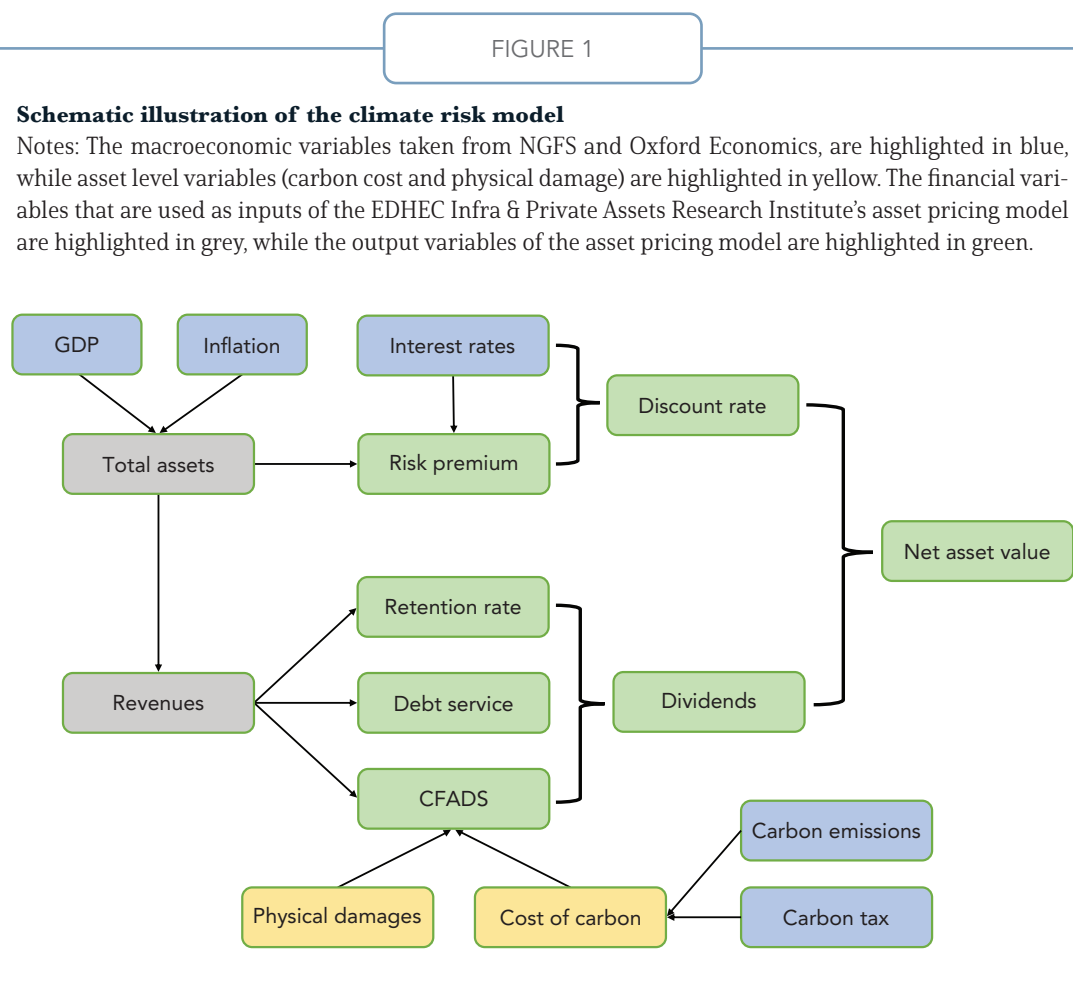
### IMPACT OF CLIMATE RISKS ON FINANCIAL PERFORMANCE

The infra300 index, representing a global sample of infrastructure companies, is used in the model to assess the impact of climate risks on a diversified portfolio of infrastructure assets. This index includes companies from various sectors, such as energy, transportation, water, and communication, providing a representative sample for the analysis. By using the infra300 index, the model can evaluate the effects of climate risks on different types of infrastructure investments, offering insights into the resilience and vulnerability of various sectors.

The results show that the costs associated with climate risks are significantly higher in the scenario where physical risks are predominant, i.e., in the No Transition scenario. In this scenario, the absence of effective climate policies leads to severe physical damage due to elevated carbon emissions and a rise in temperature. Conversely, in the Orderly Transition scenario, where climate policies are implemented systematically and early, the climate costs are the lowest due to reduced physical damage and efficient adaptation measures.

To quantify these impacts, we defined several key metrics of climate risks:

1. **Climate Cost:** This metric includes expected losses from physical damage and costs associated with carbon taxes. The analysis shows that climate costs are particularly high in the No Transition scenario due to extensive physical damage and unmitigated carbon emissions. In contrast, the Orderly Transition scenario results in the lowest climate costs.
2. **EBITDA-at-risk:** This metric measures the impact of carbon costs on a company's earnings before interest, tax, depreciation, and amortization (EBITDA). It serves as a proxy for transition risks. The results indicate that in the No Transition scenario, EBITDA-at-risk remains low due to minimal carbon taxes. However, in the Orderly and Disorderly scenarios, EBITDA-at-risk initially spikes with the introduction of carbon taxes but eventually decreases as companies reduce their emissions and adapt to the new regulatory environment.
3. **Carbon Intensity per Revenue:** This metric reflects a company's carbon efficiency relative to its revenue. The findings suggest that stringent climate policies incentivize companies to lower their carbon intensity, thereby enhancing their sustainability over time.
4. **Net Asset Value (NAV):** The NAV computations for infrastructure portfolios reveal significant variations across different scenarios. In the No Transition scenario, severe physical risks and associated



costs lead to a notable decline in NAV. On the other hand, scenarios involving transitions, particularly orderly ones, show more favorable NAV trajectories, highlighting the financial benefits of proactive climate action.

Additionally, we introduce metrics of extreme climate risk, which measure the potential losses that can be expected if actions to mitigate climate change are taken late or not taken at all:

- **Late Alignment Risk:** This metric assesses the combined effects of physical and transition risks if climate policies are implemented late. The results show that delayed action, while still costly, is less damaging than no action at all.
- **No Alignment Risk:** This metric measures the consequences of failing to mitigate climate change altogether. The findings indicate that potential losses due to not aligning at all are approximately

six times higher than the potential losses due to aligning late.

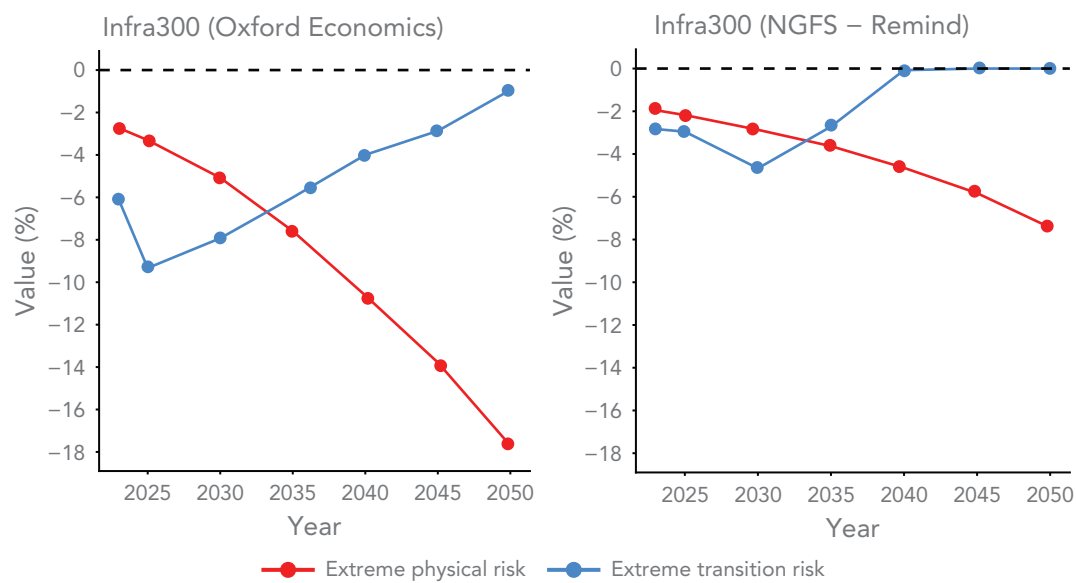
- **Extreme Transition Risk:** this metric measures the potential losses that are purely due to carbon emissions in the Disorderly Transition scenario. Since this scenario has the highest transition risks, we add an "extreme" label to it.
- **Extreme Physical Risk:** this metric measures the potential losses purely due to potential physical damage in the No Transition scenario. Since this scenario has the highest physical risks, we add an "extreme" label to it. We find that in 2050, the potential losses due to physical risks in the No Transition scenario are more than ten times higher than the potential losses due to transition risks in the Disorderly Transition scenario.

These four metrics are presented in Figure 2 and Figure 3.

FIGURE 3

**Estimations until 2050 of the extreme transition and physical risk metrics**

Note: The charts show the average over the infra300 index for both NGFS and Oxford Economics.



**CONCLUSION**

Our research paper “Computing Extreme Climate Value for Infrastructure Investments” provides a comprehensive analysis of the financial risks posed by climate change to infrastructure investments. The novel methodology developed in the paper offers a robust framework for assessing these risks, integrating climate scenarios and economic data to project future cash flows and discount rates. By leveraging the insights from NGFS and Oxford Economics scenarios, the model provides valuable guidance for investors, helping them to navigate the uncertainties posed by climate change.

Our findings emphasize the critical importance of incorporating climate risks into infrastructure investment decisions. Physical and transition risks can indeed significantly impact the financial performance of infrastructure assets, and the costs associated with inaction are substantial. Indeed, our results demonstrate that the costs of climate risks are substantially higher in scenarios with severe physical risks. Proactive climate policies and investments in greener technologies are essential for mitigating these risks and ensuring the long-term resilience and sustainability of infrastructure assets.

Overall, the paper makes a compelling case for the importance of considering climate risks in infrastructure investments, offering a comprehensive tool for managing these risks and making more informed decisions in the face of a changing climate.

# Physical Climate Risk Survey: Those in the Infrastructure Investment Industry are Concerned and Lack Data

Noël Amenc

Director

EDHEC Infra & Private Assets Research Institute  
Affiliate Member  
EDHEC-Risk Climate Impact Institute

Frédéric Blanc-Brude

Founding Director

EDHEC Infra & Private Assets Research Institute

Alice James

Writer

EDHEC Infra & Private Assets Research Institute

- These risks could be huge, and investors have no certainty on how they will affect global infrastructure.
- Physical risks could wipe as much as 54% off the value of portfolios.
- Concerned investors say they have little confidence in the advice and data they are receiving.
- Two-thirds of those polled had carried out no evaluation of this physical risk themselves.

## THE RISK: IT'S REAL, BUT WE CAN'T MEASURE IT

Investors and other industry professionals are concerned about physical climate risk and believe that they have almost no idea how it will affect unlisted infrastructure assets; that's the clear message they delivered when we surveyed them on their views regarding the risks to the asset class and whether they feel the advice and information they are getting is sufficient or even reliable.

This survey was conducted among investors and other professionals invited to a presentation of our latest research paper ([https://publishing.edhecinfra.com/papers/2024-01\\_physical%7C\\_climate\\_risk\\_survey.pdf](https://publishing.edhecinfra.com/papers/2024-01_physical%7C_climate_risk_survey.pdf)) on September 27, 2023. Key takeaways from the survey, which polled 70 professionals including managers with more than USD2 trillion under management, are as follows:

- 97% of investors polled believe physical climate risk is significant.
- Some 76% believe it will have a medium or high effect on their infrastructure investments.
- However, only 16% think we actually know how it will impact these assets.
- 76% also stated that the climate scenarios used by financial institutions to evaluate transition risk to infrastructure are inadequate for the assessment of physical climate risk.
- That said, some three quarters said that our research had helped them to better assess these risks and their potential impact.

The survey also revealed that some two-thirds of those polled had carried out no evaluation of this physical risk themselves.

In very concrete terms, this survey confirms that despite the importance attributed to physical climate risk, investors and managers are not in a position to estimate its impact on their own portfolio. This inability is all the more concerning because investor portfolios, being highly concentrated, can be very strongly exposed to physical climate risk without awareness of this. This lack of knowledge of risks raises important questions for the risk management and solvency measurement of insurance companies and pension funds, especially considering that institutional asset owners

are increasingly investing in private assets, notably unlisted infrastructure.

This survey also raises the question of the right information and the management of climate risks and their financial consequences for long-term investors in infrastructure.

## THE RESEARCH: PHYSICAL RISKS COULD WIPE AS MUCH AS 54% OFF THE VALUE OF PORTFOLIOS

In August 2023, we published a new research paper, "It's getting physical", which revealed that an investor could incur losses of 54% on the value of their unlisted infrastructure portfolio due to both the realization of climate risks before 2050 and the high level of concentration of institutional investor portfolios. This estimation was produced using the EDHEC Infra & Private Assets Research Institute database of financial and extra-financial database on unlisted infrastructure, the largest in the world today. The energy transition and the alignment of economies bring a cost to private investors, but so does climate change! Importantly, however, our research also showed that if the relevant stakeholders could only organize the transition towards a decarbonized economy today, extreme losses could be reduced by half.

The findings reveal that the physical risks created by climate change are not limited to a distant future for investors in infrastructure, some of whom could well lose more than 50% of the value of their portfolio to physical climate risk before 2050 in the event of runaway climate change. Moreover, and beyond this extreme loss, it should be stressed that the average investor will also lose twice as much to extreme weather, which corresponds to a current policy scenario, mostly in OECD countries, compared to a low carbon scenario.

On September 27, 2023 at 9am BST we held a webinar where we presented the findings of the paper to investment professionals globally.<sup>5</sup> Following this, we polled our invited audience for their views on some of the key questions regarding their views and practices regarding physical climate risk management for unlisted infrastructure assets.

Some 261 members of the investment community tuned in. (It is worth noting when scheduling live online

events that time zones mean you can broadly favor Europe, the Americas or Asia. This webinar was scheduled to appeal to European attendees and thereafter the US. Full details are in the Appendix.

## THE RESPONSES: CONCERNED INVESTORS SAY THEY NEED BETTER DATA

We posed seven questions to those invited to our webinar, some of which required simple yes/no answers, some of which were more nuanced, and several of which offered the opportunity for a narrative response. Details of each are given below, plus a selection of the written responses submitted.

### Question 1: Is physical climate risk something you consider to be significant?

- Yes: 68 (97%)
- No: 2 (3%)

Unsurprisingly, and perhaps reassuringly, our cohort was almost unanimous on this front, with 68/70 (or 97%) stating that physical climate risk is something that they do consider significant. Indeed, it is perhaps most concerning that there are two respondents who still believe that they are not. In our recent paper, we showed that such risks are already material for a number of infrastructure assets even if these are generally located in developed economies; e.g. the UN Office for Disaster Risk Reduction reported that the number of major flood events already more than doubled between 2000 to 2019, while the incidence of storms grew by 40% during the same period.

### Question 2: What impact do you believe physical climate risk will have on your infrastructure investments?

- High Impact: 23 (33%)
- Medium Impact: 30 (43%)
- Low Impact: 13 (19%)
- Other: 4 (6%)

Our respondents gave a slightly more mixed response to this question, but overall 76% stated that they anticipated physical climate risk having a medium or high impact on their infrastructure investments

<sup>5</sup> For our next event, which will take place in Chicago on October 17, 2024, please see here: <https://scientificinfra.com/private-asset-day/>.

(see Figure 1). The fact that we see such a broad spread between the responses highlights the impossibility of quantifying future damages armed with only the limited data on both effects and policy responses that we have today.

Perhaps the most interesting takeaway from the responses to this question is that close to a fifth of the polled sample of industry professionals are confident that their investments are reasonably secure; the answers to Question 1 suggest that this is not because they are blasé about climate change; it may be that they believe that their particular investments have been selected in the belief that they are less vulnerable.

There was no particular pattern to those stating they saw low impact: they were quite evenly scattered geographically. That said, those considering the potential impact would be small were overwhelmingly from the UK and Germany (see Figure 2); however, these were also the largest categories of responders, and the sample size is small.

**Question 3: Do you believe that the current state of knowledge on physical climate risk allows the value, or at least the relative size, of its impact on infrastructure investments to be genuinely measured?**

- Yes: 11 (16%)
- No: 16 (23%)
- Somewhat: 38 (54%)
- Not Sure: 5 (7%)

Responses to this question were more nuanced, but the overall message is one of a lack of confidence in our current ability to gauge the magnitude of climate risk impact on the asset class (see Figure 3). Just 16% believe we currently have the tools to get it right.

That said, more than half do believe we are part-way there, which is encouraging but suggests that research will have to improve substantially to reassure the investment community that they have all the data needed on the potential magnitude of climate risk impact.

In terms of clustering geographically, UK responders were the most negative, casting seven out of the 16 “no” votes (see Figure 4). That said, the sample size is small.

**Question 4: Has the research carried out by the EDHEC Infrastructure & Private Assets Research Institute allowed you to assess this risk and its impact better? Yes/No? Please explain why.**

- Yes: 40 (75%)
- No: 13 (25%)

We regularly poll our clients and those in the wider community for their views on key developments within the industry, the challenges they face, and how we are helping them in this space. As such, it is reassuring that some 75% of respondents stated that our research is helping them to understand the climate risks that threaten investments in this field and their impacts.

Below is a section of the narrative responses:

- With nil background I was persuaded by EDHEC’s methodological approach. You really have to get granular, and it’s difficult to diversify away from the risk.
- Yes, investment into infrastructure will continue within multi asset funds, but we need to be aware of the ever-changing material risks associated.
- This whole body of work will evolve, and it is really important to look at physical risk sooner rather than later.

FIGURE 1

**It’s tough to quantify future damage armed with limited data**

**What impact do you believe physical climate risk will have on your infrastructure investments?**

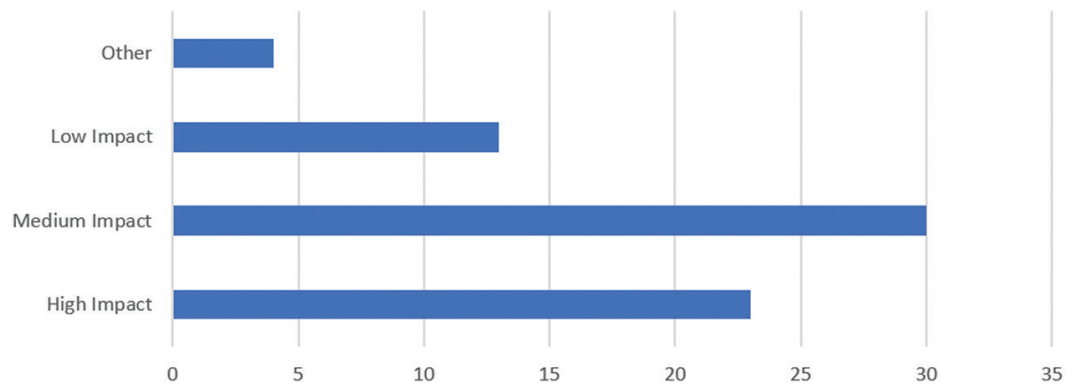


FIGURE 2

**Those seeing low impact were mostly from the UK and Germany**

Notes: This graph shows the geographical distribution of responses from the UK, Germany, Switzerland and the Netherlands. Together these accounted for 40 of the 70 respondents.

**What impact do you believe physical climate risk will have on your infrastructure investments?**

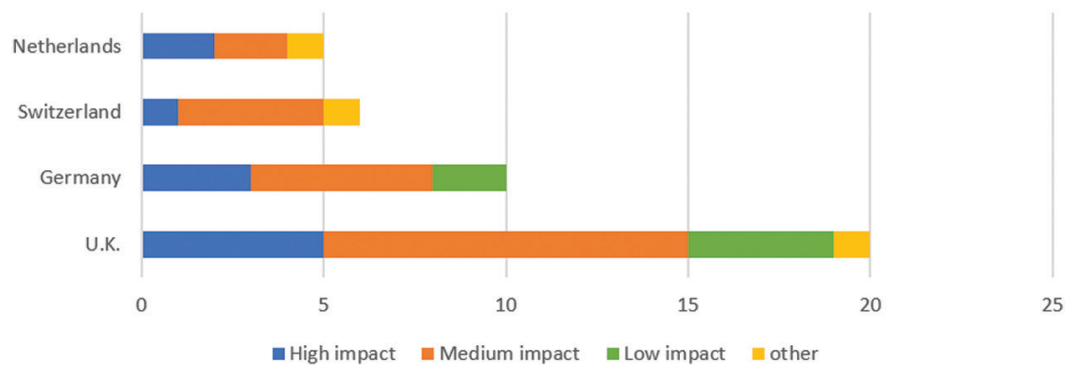


FIGURE 3

**There’s little confidence that we have the tools to get things right**

**Do you believe that the current state of knowledge on physical climate risk allows the value, or at least the relative size, of its impact on infrastructure investments to be genuinely measured?**

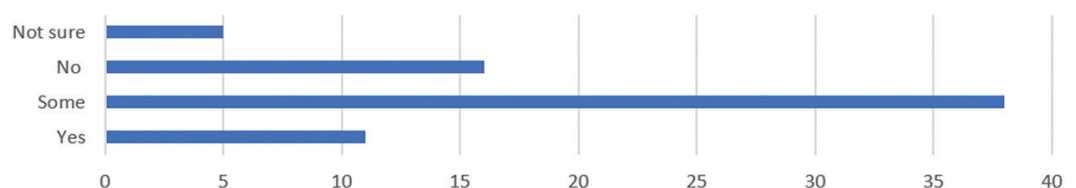


FIGURE 4

**UK responders were the most negative**

Notes: This graph shows the geographical distribution of responses from the UK, Germany, Switzerland and the Netherlands. Together these accounted for 40 of the 70 respondents.

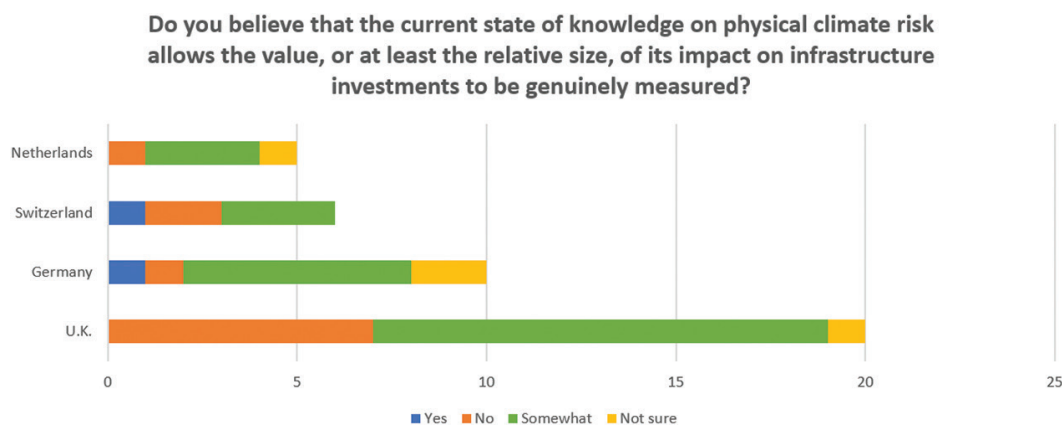


FIGURE 5

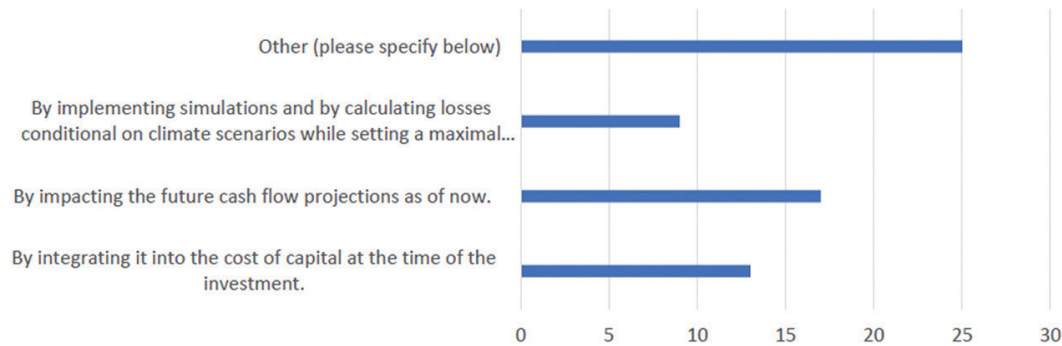
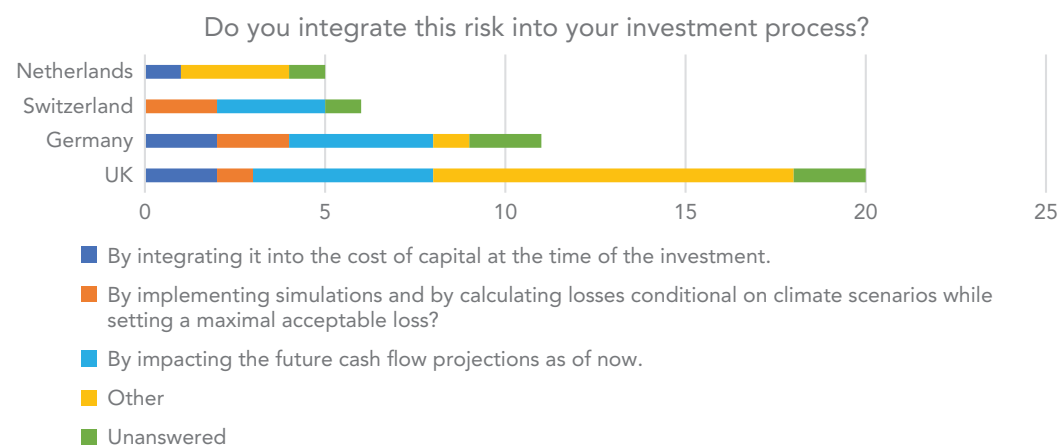
**Approaches to incorporating risk varied greatly****Do you integrate this risk into your investment process? If so, how?**

FIGURE 6

**Effective integration is at an early stage**

Notes: This graph shows the geographical distribution of responses from the UK, Germany, Switzerland and the Netherlands. Together these accounted for 40 of the 70 respondents.



- Helpful perspectives on the methodology and data needed to try to predict climate risk and value at risk to a given asset under a given scenario.
- I learned that it is important to consider the probable impact of physical risks and to be as precise as possible in its estimation. We would assign the Asset Manager to initiate an analysis.

- It allows us to consider that physical risks could eventually be higher than estimated.

**Question 5: Have you implemented an evaluation of this physical risk yourself?**

- Yes: 24 (34%)
- No: 46 (66%)

Two thirds of respondents have carried out no evaluation of physical climate risks themselves. This response serves to highlight just how dependent professionals in the industry are on the advice and data available from researchers and consultants. It is clear that this lack of real evaluation of the climate risk to which investors' assets are exposed heightens the risk to which these assets are exposed, because these same investors have highly concentrated investments in assets whose exposure to potentially very high risks is not measured.

**Question 6: Do you integrate this risk into your investment process? If so, how?**

- By integrating it into the cost of capital at the time of the investment. 13 (20%)
- By impacting the future cash flow projections as of now. 17 (27%)
- By implementing simulations and by calculating losses conditional on climate scenarios while setting a maximal acceptable loss? 9 (14%)
- Other (please specify below). 25 (39%)

The replies to this question show how very varied approaches to incorporating risk can be—even when considering a single class of risks on a single asset class within a highly regulated industry (see Figure 5). Responses were spread across the four options, with 25 saying they use a different approach to integrate physical climate risk into their investment process, 17 favoring impacting the future cash flow projections as of now, 13 integrating it into the cost of capital at the time of the investment and nine by implementing simulations and by calculating losses conditional on climate scenarios while setting a maximal acceptable loss.

The "Other" option refers essentially to investors who do not have a quantified or formal approach to assessing climate risk in the investment process. It should be noted that even when the investments have a process that integrates this risk, the inadequacy of the assessment of the reality of this risk makes this integration questionable (see Figure 6).

**Question 7: Specifically for infrastructure, do you believe that the climate scenarios used by financial institutions to evaluate transition risk are adequate for the assessment of physical climate risk?**

- Yes: 11 (24%)
- No: 35 (76%)

Once again, the answers to this question reveal industry professionals' frustration with the data that is available to them (see Figure 7). More than three quarters do not think that the climate scenarios used by financial institutions to evaluate transition risk are adequate for the assessment of physical climate risk.

Below is a selection of the narrative response to this final question:

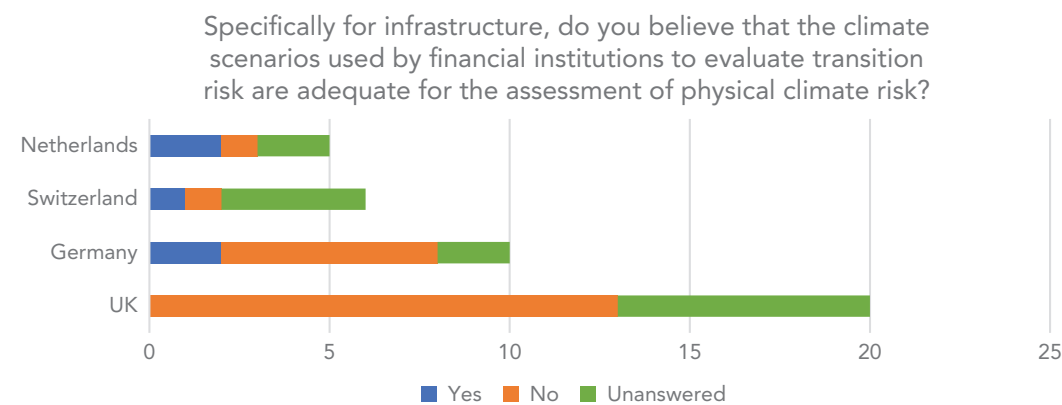
- No—definitely not. There are some huge concerns around the present state of scenarios ... but fortunately, further work is ongoing to develop better scenarios.
- Not ideal but is probably a good way to think about it. Otherwise you will have separate set of scenarios for transition risk and a separate set of scenarios for physical risk. And can't combine risks.
- I suspect the risk is currently understated and reflective of experience rather than potential futures.
- No, because current models run on regression of historical data and climate change might bring us a completely unknown future scenario.
- No, they are present and in development but insufficient or inadequate. Right now we apply full risk methodology with no regards for the project specificities, it needs to be tailored by sector.
- Yes because these scenarios exist and allow to share a common understanding.



FIGURE 7

**Few see climate scenarios as adequate for climate risk assessment**

Notes: This graph shows the geographical distribution of responses from the UK, Germany, Switzerland and the Netherlands. Together these accounted for 40 of the 70 respondents.



These responses are generally consistent with our research and with the importance of going beyond the NGFS scenarios to estimate physical climate risk.

The EDHEC Infra & Private Assets Research Institute is improving on the macro-level understanding of physical risk, which consists of a national-level damage function impacting the productivity of factors, by estimating very granular physical risk exposures at the asset level (down to a 30-metre resolution) for floods, storms, and heat. This technology combined asset-level characteristics, e.g. types of physical assets, with the most recent assessment of physical hazards and state-of-the-art, hazard- and activity-specific damage function damage functions. The result is a refined estimate of the Physical Damage at Risk (PDaR) for a given hazard return period today, which can serve as the basis for asset-level physical risk exposures in different scenarios.

**CONCLUSIONS**

Our survey reveals that industry professionals have much pessimism about the data they are being given regarding physical climate risk, considering it to be both incomplete and unreliable. They have doubts about the models being used, and they want more and better research.

Responses to the seven questions highlight the following:

- Responders overwhelmingly consider that physical climate risk is something significant.
- Expectations of its impact vary hugely, but most believe it will have a medium or high impact on their infrastructure investments.
- They display a lack of confidence in our current ability to gauge the magnitude of climate risk impact on the asset class. Very few believe we currently have the tools to get it right.
- Most say that our research is helping them to understand how these risks threaten investments in this field and their potential impacts.
- Most have carried out no evaluation of physical climate risks themselves.
- Almost all integrate consideration of these risks into their investment process, though in many different

ways, and most of those who do not do so yet say they plan to.

- Most believe that the climate scenarios used by financial institutions to evaluate transition risk are inadequate for the assessment of physical climate risk.

This high level of risk shows the importance of implementing more ambitious policies to cope with climate change. The energy transition and the alignment of economies bring a cost to private investors, but so does climate change! Importantly, however, our research also showed that if the relevant stakeholders could only organize the transition towards a decarbonized economy today, extreme losses could be reduced by half.

And our research has shown that investors are right to be concerned and to question the caliber of the data that they are receiving. On the one hand, runaway climate change could lead to losses as large as half of the portfolio of some investors because of physical damage; on the other, a delayed transition, even if it achieved decarbonization, would create a gigantic price and interest rate shock and could wipe out as much as USD600 bn of infrastructure asset value for the same investors.

The climate impacts and risks to infrastructure assets are a key point of focus but investors often lack the full picture of their level of impact or exposure. And they are incorporating them into their strategies in many different ways. Moreover, physical risk estimates are often simplified to a 'point on a map' estimation and do not take into account the granularity of the terrain or the type of damage that different hazards can cause to an asset.

Proper integration of climate risks requires an evaluation of the impact of these risks, which, the survey shows, has been insufficiently developed. It is clear that given the level of concentration of the portfolios, and therefore of the potential concentration in the riskiest assets, proper knowledge of these risks and their consequences is essential. The results of the survey show that this is not unfortunately the case currently.

**APPENDIX: BREAKDOWN OF WEBINAR ATTENDEES**

Some 261 industry professionals tuned in to our webinar. The full results are as follows:

Nature	Attended
Asset Managers	97
Asset Owners	51
Consultants	42
Banks	21
Regulators	9
Others	41
Total	261

Location	Attended
United Kingdom	66
France	42
Switzerland	25
Germany	23
United States of America	17
Netherlands	16
Australia	10
Luxembourg	8
Singapore	7
Denmark	5
Hong Kong	5
Norway	5
Japan	4
Ireland	3
Sweden	3
Austria	2
Canada	2
China	2
Finland	2
Iceland	2
Italy	2
South Africa	2
Andorra	1
Croatia	1
Kenya	1
Morocco	1
Parked	1
Portugal	1
Spain	1
Vietnam	1
Total	261

# Low Tide: Benchmarking Risks in Infrastructure Investments: What the Data Showed about Thames Water

Frédéric Blanc-Brude  
Founding Director  
EDHEC Infra & Private Assets  
Research Institute

Abhishek Gupta  
Associate Director  
EDHEC Infra & Private Assets  
Research Institute

Tim Whittaker  
Research Director and Head of Data Collection  
EDHEC Infra & Private Assets  
Research Institute

- In this paper, we ask what investors in Thames Water could have learned about the entity's risk and likely market value had they compared its characteristics to market and peer group data.
- We show that a straightforward comparative analysis would have signaled a high-risk, low-return profile that should have raised numerous red flags.
- The company's incentives were twisted by an extremely low regulatory weighted average cost of capital; as a response, previous investors extracted the maximum amount of cash as fast as possible, creating a huge debt pile.
- Its exposure to key risk factors had been high, and rising, for a significant period of time, pointing to a likely loss in value that was not recognized for years.

## THAMES WATER'S DRAMATIC IMPAIRMENT WAS ENTIRELY PREDICTABLE

A large water and wastewater utility like Thames Water epitomizes the "stable and predictable" cash flows that investors are attracted by in the infrastructure asset class. Yet, in December 2022, the value of this investment was impaired by almost 30%, an abrupt and unexpected loss of approximately GBP1.5bn (the company was previously valued at c.GBP5bn by its owners) for investors including UK, Japanese and Canadian pension plans. Only nine months earlier, in March 2022, some investors were still increasing the valuations of their stakes.

Yet a straightforward comparative analysis reveals the emergence of a high-risk, low-return profile that should have raised numerous red flags and prompted long-term investors seeking a 'boring' investment to reconsider. For a large water utility to lose so much value so fast, the investment must in fact have been mispriced for several years leading up to the impairment. Our own assessment is that its value had indeed been decreasing for years and will likely decline more from the current reported valuation.

Without this analysis, investors fell prey to a form of self-referencing or 'absolute thinking' that unfortunately remains very common in infrastructure investment: it's about the one asset, not the market or peers. This narrow vision can obscure the big picture and the role played by market dynamics i.e., the systematic drivers of the fair market value of private infrastructure companies. Because infrastructure assets are large and illiquid, once invested, it can be hard not to 'fall in love with your position' since it is difficult to change easily or quickly. But taken in isolation, a single asset is often more of a story than a hard quantitative assessment.

We argue that benchmarking the key characteristics of the asset would have allowed a much better understanding of its risk profile. Taking a relative view requires representative and robust information to build benchmarks and point of reference to which the risks and performance of infrastructure assets can be compared. When this information is available, investors

can better understand the kind of investments they have made, because they can compare them to the right benchmark. In this article, we use such a database of financial data for similar and comparable investments and examine the difference between robust but representative benchmarks and the data available for Thames Water and its holding company Kemble Water<sup>6</sup>.

Most infrastructure assets are in some ways unique and will differ from the average in their sector or country. However, when compared with a large and robust sample, any large differences from the benchmark provide indication of not only how unique an infrastructure company is, but also of how confident (or worried) investors should be about its ability to deliver "stable and predictable cash flows". The difference between an investment's characteristics and its benchmark does not necessarily signal problems, but it is something that investors should be able to understand and explain; and, yes, in some cases it can be a red flag.

There are three red flags that investors could have considered long before Thames Water had to be brutally impaired at the end of 2022. Had these been identified up front, they could have provided a cause for remedial action or a revaluation of the asset much earlier on.

### RED FLAG #1: THE REGULATED COST OF CAPITAL

#### Toxic incentives meant that Thames Water wasn't a "normal" utility

The company should not have been expected to behave 'normally' as its incentives were twisted by an extremely low regulatory weighted average cost of capital (or WACC) that could only logically push it to take on too much risk to achieve the level of returns required by the market. While this is true of the whole sector, the gap between Thames Water's market WACC and its regulated version is the largest of all of its peers.

#### OfWat's failures

Thames Water is one of 17 regulated water & sewage companies in the UK. They are to a large extent natural monopolies and need to be regulated to

minimize the welfare impact of monopolistic behavior. For a monopoly such as a water company, it is rational and profit maximizing to underinvest in its asset and to overcharge its customers, irrespective of whether it is publicly or privately owned. For these reasons, regulatory oversight is required and aims to have the firm maintain or improve the quality and quantity of service, while limiting the cost to the consumer.

In England and Wales, this is achieved through incentive regulation by OfWat, the Office of Water Services. The regulator aims to promote productive efficiency by setting tariffs at a level representing that for which an efficient service provider would also earn a fair return. The regulator's view on the firm's cost of capital thus allows setting tariffs while taking into account the need to invest in the asset and the service required of the company, for instance the treatment level of wastewater discharge, but also the level of leakage in the water network, or its expansion.

Of course, the cost of capital is also a key data point for an investor in a private company or project: if the expected return from the investment does not at least equate the cost of capital, then the investor should walk away from the project—or find a way to increase returns.

We argue that the regulator of Thames Water has been setting the WACC inadequately, using a long invalidated asset pricing model as well as the wrong data.

As a result of setting the WACC at a very low level, OfWat was better able to meet its social mandate objectives: to keep water tariffs lower than they otherwise would be if the firms had their way.

However, it also increasingly created toxic incentives for the firm and its investors, who were faced with a higher market cost of capital and therefore had to engage in adaptive tactics to meet their own return targets in a context where the regulator would not recognize the level of return required by the market to invest in a utility company regulated by OfWat.

This process and the level of the WACC imposed by the regulator are public knowledge and of course known to investors. The implications for the firm's behavior become a matter of simple economic

<sup>6</sup> For an in depth version of the research presented here, please go to: [https://publishing.edhecinfra.com/papers/2024\\_low\\_tide\\_research\\_paper.pdf](https://publishing.edhecinfra.com/papers/2024_low_tide_research_paper.pdf). Following the publication of this paper two of the major investors in Thames Water have written down their holdings significantly, one has fully written off the investment. This is due to the realization of significant risks that were inherent in the structure that were observable many years ago as detailed by this research.

FIGURE 1

**Weighted average cost of capital for Thames Water and several peer groups**

Source: infraMetrics, pre-tax, nominal.



TABLE 1

**Dividends and shareholder loan repayments to the shareholders of Kemble Water Holdings from 2007 to 2022**

Notes: All figures are in £Million. Kemble Water is the holding company of Thames Water.

Year	Dividends	Shareholder Loans	Total Payouts
2007	0	0	0
2008	72.6	29.4	102.0
2009	187.2	34.7	221.9
2010	156.4	34.6	191.0
2011	115.1	34.9	150.0
2012	165.1	34.9	200.0
2013	74.5	17.5	92.0
2014	43.6	54.9	98.5
2015	61.6	36.9	98.5
2016	1.5	0.0	1.5
2017	22.8	77.3	100.1
2018	0	0.0	0.0
2019	0	0.0	0.0
2020	0	0.0	0.0
2021	0	0.0	0.0
2022	0	0.0	0.0

reasoning: faced with a higher cost of capital than the one it is allowed to recoup by the regulator, a firm can make the choice to walk away from the investment (at a very large cost) or to increase the risk profile of the investment to extract a higher return, more aligned with

its own cost of capital, but at the expense of bringing the firm to the brink of insolvency.

The inability of the regulator to take the market price of risk into account when estimating the fair return of the private sector thus played a role in pushing the

water utility to adopt a reckless behavior to reach the level of return required by the market.

Crucially, this behavior should have been clear to any new investor acquiring shares in the HoldCo as historic investors chose to exit the investment. In other words, a comparative analysis of the market costs of capital of Thames Water with its regulated cost of capital left little ambiguity as to where the firm stood in terms of incentives.

**REG FLAG #2: CAPITAL STRUCTURE & DIVIDEND PAYOUTS****Payments to shareholders exhausted the balance sheet and created a mountain of debt**

As a response, investors in Thames Water created a structure to extract the maximum amount of cash as fast as possible, which also created a huge debt pile, leading to a necessity to conserve capital. It should have been clear from 2016 onwards that there would be no potential for further payouts for many years.

**“A potted history”**

Following the passage of the Water Act 1989, Thames Water was privatized and listed on the London Stock Exchange in 1989. From 1989 to 2000, Thames Water was an independent company, during which times it pursued a growth strategy by buying or setting up businesses around the world. By the year 2000, Thames Water had companies with operations in Malaysia, Thailand, Singapore, Australia, Chile, Turkey. Whilst most of these companies were related to the provision of water and waste water, Thames Water also entered property development as well as consulting businesses. Leverage (debt to total assets) also increased during this time. From 6.45% in 1991, it had risen to 33.90% by the year 2000.

In 2000, RWE Group, a large German utility successfully took over Thames Water and continued with the practice of expanding the group into areas unrelated to its roots of providing water and sewage services to London. By December 2001, the revenue from the regulated utility accounted for 63% of sales Thames Water's total revenues. The number of countries Thames Water was operating steadily increased, as it added businesses in Chile, further projects in Turkey and the US. During this period of RWE ownership, the business even invested in the London Underground PPPs, buying 20% of the ill-fated Metronet Rail SSL and Metronet BCV SPVs.

In 2004, Thames Water group conducted a strategic review and came to the view that it should focus on the UK and Europe. As a result, large sections of the international business were sold. Of total group revenues in 2004 of £1,945.7 million, the businesses from the Asia Pacific and Americas only contributed £89.3 million and £75.8 million, respectively. It could be concluded that these businesses were more of a distraction rather than contributing significant value. In 2005 RWE conducted its own strategic review, concluding that the group is to focus on electricity and gas supply rather than continue holding onto regulated water assets. The group announced that Thames Water would be sold by 2007 and any proceeds would be returned to shareholders by way of special dividends. Whilst initial estimates for proceeds from the sale would be £7 billion to £12 billion, Thames Water was eventually sold to a Macquarie Bank company, Kemble Water Holdings, for £8 billion (an equity value of £4.3 billion and the assumption of £3.2 billion of debt.)

It is during the subsequent years, from 2007 to 2017, that we can observe a real change in the way Thames Water was managed. Gone were the attempts to expand into other industries and countries; from 2007 there was a focus on the utility, accompanied by significantly increased leverage and distributions to shareholders. In the early years of the Macquarie consortia controlling Thames Water, large dividends and interest

on shareholder loans were paid. However, from 2015 the balance sheet capacity for Thames to support such distributions appears to be exhausted. Whilst there were still dividends and interest on shareholder loans paid in 2016 and 2017, since then very little cash has been distributed to share-holders. In 2017 Macquarie ended its association with Thames Water, selling its final stake to Omers and Wren House, with other investors also selling out to the current shareholders.

### RED FLAG #3: RISK FACTOR EXPOSURES

#### How risky can a utility really be?

Thames Water's exposure to key risk factors that have been shown to drive market prices has been high, and rising, for a significant period of time: this leads to an increasingly higher market risk premium and therefore discount rate and a likely loss in value that was not recognised for years.

#### How Thames water stopped being 'Boring'

There are strong public policy considerations for ensuring that a utility remains functioning and providing a service. As a result, because they provide the necessities of life and despite being complex businesses to operate, utilities should, in theory, be relatively low risk for investors. They are sometimes described as 'boring' because they are stable and predictable.

There are four main risk factors found to explain the returns of infrastructure assets: leverage, profitability, size and investment.

#### Leverage

Leverage is a key risk factor in examining the returns of infrastructure assets. As shown in Blanc-Brude and Gupta (2021), leverage is positively linked to the risk premium of an asset; the more leverage, the higher the risk of future dividends *ceteris paribus*. In the case of Kemble Water, the asset is significantly more leveraged than other similar water assets and compared to infrastructure as a whole.

#### Profitability

The second factor that helps explain the risk premium for infrastructure is Profitability (Net Profit After Tax/Total Assets). This factor exhibits a negative relationship with the risk premium of infrastructure assets i.e., higher profits indicate more likely future dividend payouts and a lower discount rate. For regulated water utilities we would not expect high profits. The UK utilities sector has seen its profitability drop by almost 30% since 2015. Crucially, Kemble Water's profitability is significantly lower than that of its peers. This would have a negative impact on the risk premium for Kemble, compared with other utility assets, resulting in a higher discount rate. With the trend for profitability negative, we would also witness an ever-increasing risk premium over time.

#### Size

The third factor presented here is size, or the total assets of a firm. Size was found to have a positive relationship with the risk premium for infrastructure assets (see Blanc-Brude and Gupta, 2021). The larger the asset, the greater the return because the asset is more illiquid and more complex. Kemble Water is significantly larger than its peers in both the UK water sector as well European and Global utilities. As a result, investors would again expect a higher risk premium for Kemble Water than other infrastructure assets. However, the general trend of growth in the size of the asset stopped in 2020.

#### Investment

Finally, we consider the Investment factor (Capital Investment/Total Assets). Blanc-Brude and Gupta (2021) found that a higher investment factor results in a higher risk premium for assets. Indeed, during

FIGURE 2

### Leverage of Kemble Water Holdings compared to the median leverage for UK water utilities and global infrastructure

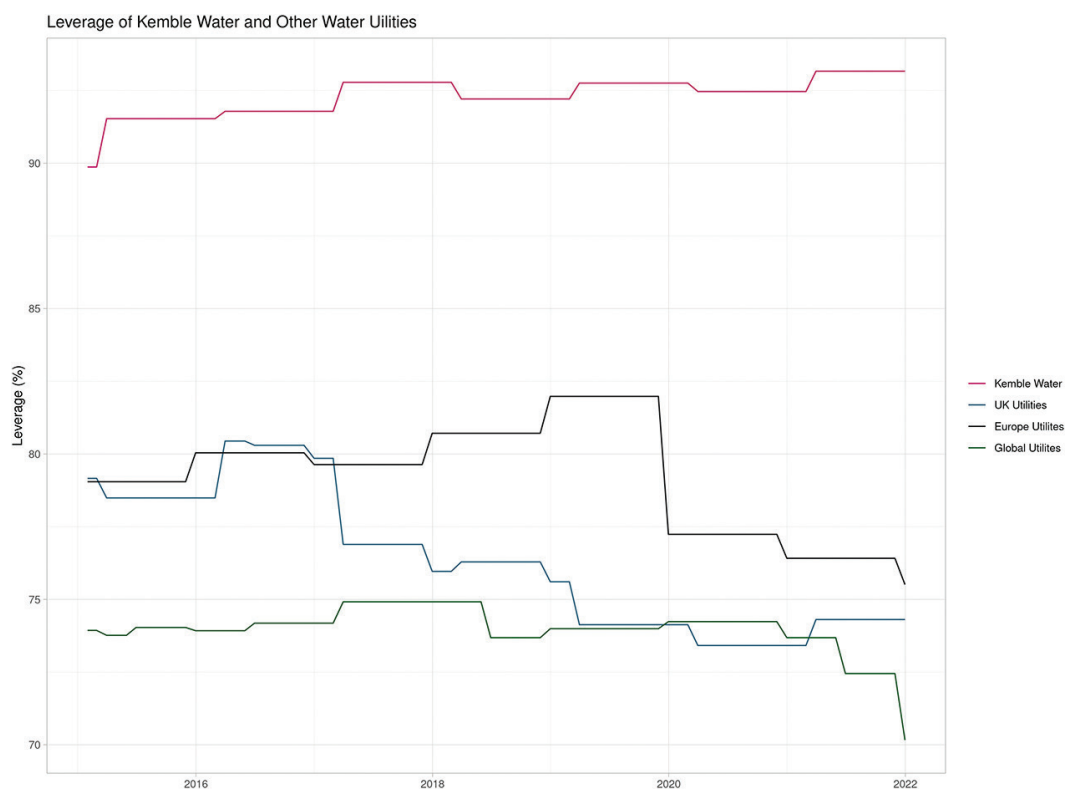


FIGURE 3

### The investment factor of Thames Water vs its peers



periods of higher investment, infrastructure companies face higher risks of delays and cost-overruns, which are well-known problems in large capital projects. All these effects make future cash flows more uncertain and increase the risk premium.

Kemble Water and UK utilities have comparable investment factor exposures. This is understandable as they are governed by the same investment/regulatory cycle. However, there have also been changing

investment cycles that have resulted in changing risk premiums. Specifically, an increase in the factor exposure around 2015 and 2016 for UK water utilities and Kemble Water respectively increased expected returns, with a subsequent decrease from 2018. This change in the factor, first up then down, would have led to similar movements in the risk premium for Kemble Water and, consequently, the discount rate and valuation. Still, throughout the period, we also see that Kemble is

investing increasingly less, as a function of its size, than its peers in the UK.

We can also observe that, for both Kemble and UK utilities, the investment factor is higher than for European or Global utilities. This would indicate that the risk premium should be higher, hence a higher expected return.

#### A high-risk profile

From this comparative analysis of the key systematic risk factors to which Kemble Water is exposed, investors should have been able to conclude that the investment:

- was highly levered;
- produced low profits compared to its peers;
- was very large;
- had low capex compared to other utilities; and
- was much more volatile than its peers.

These had obvious consequences for the valuation of the asset.

#### CONCLUSION

These findings should have at the least led the latest investors to question of the reported value of the company—not to mention the fact that the reported valuation had in fact increased over time—because they all signal that Thames Water should have instead been losing value for many years. Using our own benchmarks to generate a comparable set of data points for a typical company with the same characteristics as Kemble Water, our measures of risk factor exposure, duration (exposure to interest rate risk) and likelihood of dividend payouts signal that that the firm is likely to have lost between 30% and 50% of its value over the past decade, in large part due to the evolution of its risk profile and the market price of risk.

While this does not constitute a formal assessment of the fair value of Thames Water and its holding company, it is a robust point of reference from which investors should have questioned what they knew and the valuation of the asset.

#### REFERENCE

**Blanc-Brude, F. and A. Gupta** (2021). *The volatility of unlisted infrastructure investments*. EDHEC Business School.

# Achieving Diversification in Unlisted Infrastructure Investment: A Smart Infra Portfolio Construction

Frédéric Blanc-Brude  
Founding Director  
EDHEC Infra & Private Assets  
Research Institute

Abhishek Gupta  
Associate Director  
EDHEC Infra & Private Assets  
Research Institute

Moataz Farid  
Quantitative Analyst  
EDHEC Infra & Private Assets  
Research Institute

- Unlisted infrastructure investments are notably illiquid due to their substantial size and their few secondary market transactions, creating challenges for portfolio construction.
- Despite these limitations, large institutional investors pursue infrastructure investments for diversification purposes.
- Achieving broad diversification in this asset class is difficult because the lack of liquidity restricts entry and exit points, complicating portfolio rebalancing.
- Additionally, the inability to short sell in private markets also limits the scope of infrastructure investing to a long-only strategy.

## INTRODUCTION

Previous research has suggested that unlisted infrastructure equity offers a significant potential to improve total portfolio diversification; however, this is on the assumption that the asset class is accessed on a well-diversified basis (Amenc et al., 2022). But what does this mean for an investor in infrastructure in practice? Is there a minimum number of assets or sectors that justifies using the phrase “well-diversified” in the annual report? Is a portfolio of just 10 infrastructure assets necessarily under-diversified? We show that answering these questions is not as simple as totting up the assets, sectors, or countries in which individual investments have been made<sup>7</sup>.

In this paper, we aim to answer two questions:

### 1) Is it feasible to build a diversified infrastructure portfolio?

We construct several portfolios using a “brute force approach”. These are 100 equally weighted random portfolios for each target number of constituents, from 5–100, irrespective of any other sector or geography criteria. These “brute force” strategies show that on average portfolio diversification can be achieved by increasing the number of assets in the portfolio. However, holding a large number of assets in an infrastructure portfolio is not feasible (Amenc et al., 2023). While infrastructure investments are very heterogeneous and different from one another, it is important to recognise the existence of common risk factors in a portfolio of such investments. We show that achieving a well-diversified portfolio of infrastructure investments is nonetheless possible with a limited number of investments—as long as the key risk factors found in these investments are used to build the portfolio accordingly.

### 2) What role do infrastructure investments have in a multi-asset class portfolio?

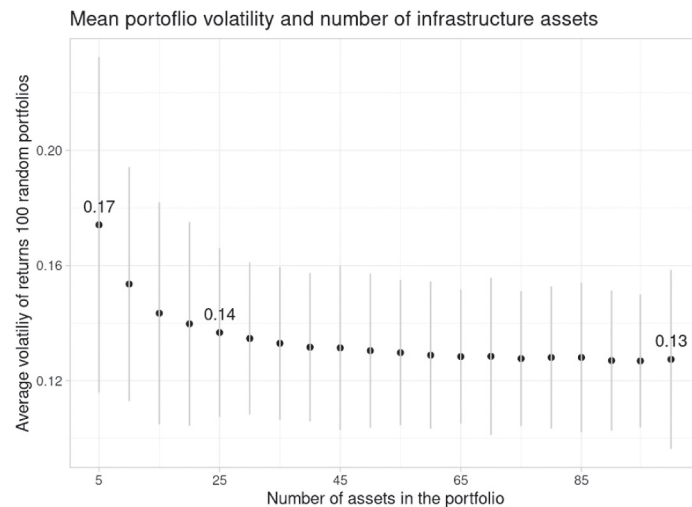
We construct a portfolio that include nine asset classes. We then add infrastructure to the portfolio and examine the implications using different optimisation techniques such as return targeting, risk targeting and equal risk contribution. We show that infrastructure investments can have a weight ranging from 4.4–13.1% depending on investors’ risk profiles.

FIGURE 1

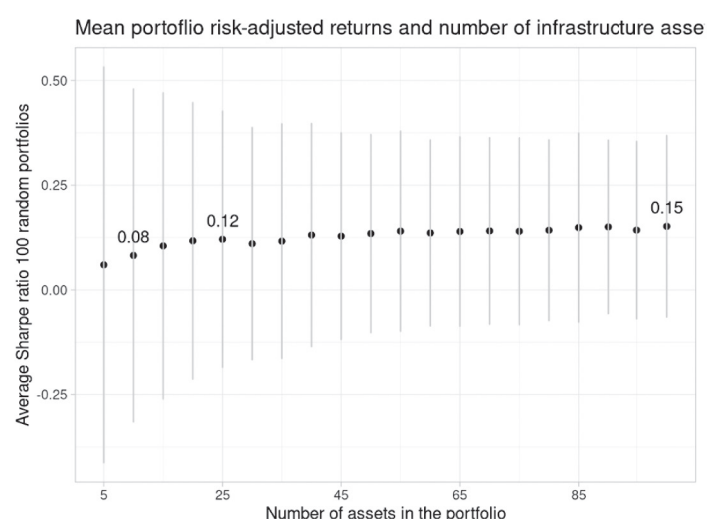
### Brute force diversification approach

Notes: The dotted points are the average of 100 randomly chosen portfolios for each number of assets. The grey bars are the 95% confidence intervals. Panel A demonstrates the average volatility of 100 random portfolios for the Brute-Force diversification by number of assets. Panel B demonstrates the average Sharpe ratio of 100 random portfolios for the Brute-Force diversification by number of assets.

Panel A:



Panel B:



<sup>7</sup> A longer version of this paper is available here: [https://publishing.edhecinfra.com/papers/2024\\_smart\\_infra.pdf](https://publishing.edhecinfra.com/papers/2024_smart_infra.pdf).

## PORTFOLIO CONSTRUCTION: BUILDING A WELL-DIVERSIFIED INFRASTRUCTURE EQUITY PORTFOLIO

### Building infrastructure portfolios using “brute-force” diversification strategies

In this section we consider different strategies to diversify a portfolio invested solely in unlisted infrastructure asset class. We first consider allocating capital across a range of assets, sectors, or geographies. These approaches reflect the way diversification is often presented by fund managers. We label them “brute-force” diversification strategies because they rest on the simple assumption that “more is less” i.e., more assets, sectors, countries result in less risk.

To build the infrastructure portfolio, we sample randomly from the 600+ assets in the infraMetrics® database and produce 100 portfolios of five assets, 10 assets, 15 assets, etc.<sup>8</sup> For each group by number of assets, we compute the average return, risk and Sharpe ratio for the 100 portfolios. We show in Panel A of Figure 1 that to achieve diversification, fund managers must hold a large number of assets; it takes at least 100 assets to substantially reduce portfolio volatility and achieve an average volatility of 0.13. As the number of assets increases, the 95% confidence interval (illustrated by the grey vertical lines) narrows, indicating that the dispersion of the volatility and Sharpe ratio is decreasing. This suggests that the predictability of the portfolio’s performance improves with more assets, as idiosyncratic risks are diversified away. However, the marginal benefit of adding more assets diminishes with each additional asset added. Reduction in volatility is very minimal beyond 25 assets.

We then investigate the risk-adjusted returns across different strategies, such as adding more TICCS® industrial sectors and geographies into the portfolio. Table 1 shows an illustration of building an infrastructure portfolio across 12 sectors and 12 regions. Although on average the Sharpe ratio is 0.15, the upper and lower bounds of the confidence interval suggest that this might vary significantly within each strategy and there is no guarantee that all the portfolios (including those with 12 sectors or 12 countries) achieve higher diversification benefits. This is because many of the common factors that explain returns are not *sector specific* but instead arch back to the *fundamentals of private companies*: profits, size, leverage, etc.

Private infrastructure assets represent an indivisible investment, making constructing a portfolio with a large number of assets can be not only impractical but also financially unfeasible. Consequently, private infrastructure investors are typically restricted to holding a small number of assets. Amenc et al. (2022) show that fund managers hold on average no more than 25 infrastructure assets in their portfolio at any one time, making the Brute-Force diversification strategies unachievable.

### Building infrastructure portfolios using the Smart Infra approach

To reduce idiosyncratic risk within the portfolios, we use the logic of factor investing in the context of unlisted infrastructure investments. This strategy involves assessing individual infrastructure investments for their exposure to key systematic risk factors and tilting our portfolios toward assets that have high exposure to these systematic risk factors. These five key risk factors are proxied by firm-level financials and a country risk factor and are then used in the infraMetrics model as illustrated in Table 2. We refer to this approach as “Smart Infra”, as it follows a multi-step approach that not only tilts towards a given factor or group of factors, but also achieves diversification within the factors tilt through the combination of alternative weighting schemes. This is a multi-step approach as illustrated in Figure 2.

TABLE 1

#### Comparison between the three brute-force diversification strategies

Notes: Comparison used 100 assets from 100 simulated portfolios and risk factors diversification based on 100 simulated portfolios of 25 assets. Results are in USD.

	100 Assets— Brute-Force Strategy	100 Assets & 12 Sectors	100 Assets & 12 Countries
Annualized Return	2.9%	2.8%	2.9%
Annualized Risk	12.6%	12.6%	13%
Sharpe Ratio	0.15	0.14	0.15
[Upper, Lower Bound]	[-0.03,0.32]	[-0.001,0.29]	[-0.09,0.39]

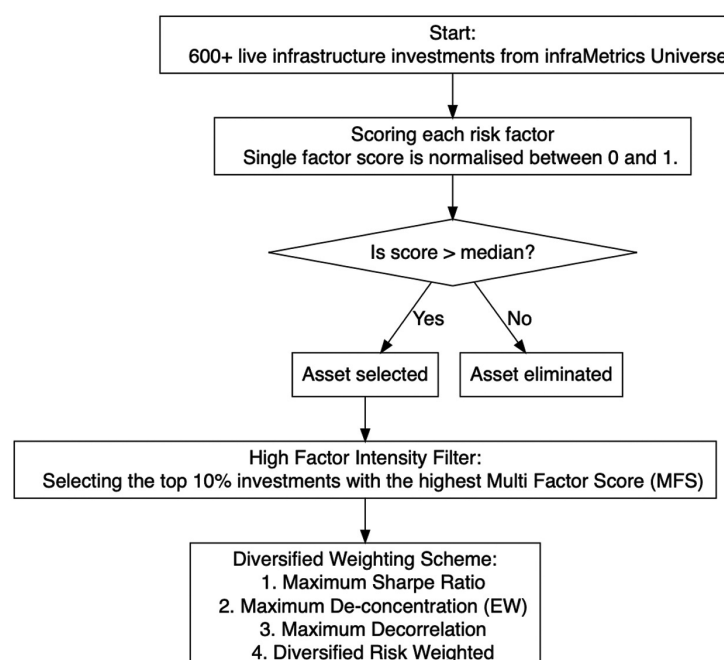
TABLE 2

#### InfraMetrics key systematic risk factors

Factor	Definition (proxy)	Effect on Price	Economic Rationale	References
Size	Total Assets	Negative	Larger assets are more illiquid and complex transactions.	Fama and French (1993)
Leverage	Total Debt/ Total Assets	Positive	Higher leverage increases the risk of future cash flows to shareholders.	Blanc-Brude and Tran (2019)
Profits	Return on Assets Before tax	Positive	Higher profits make future dividend payouts less uncertain.	Blanc-Brude and Tran (2019)
Capex	Capex/ Total Assets	Negative	Higher Capex increases the risk of construction cost overruns and delays, making future dividends more uncertain.	Blanc-Brude and Tran (2019)
Country risk	Term Spread	Positive	More uncertain long-term macro prospects (yield curve slope) correlate with greater risks for investors in infrastructure.	Chen and Tsang (2013)

FIGURE 2

#### Smart Infra multi-step approach



<sup>8</sup> <https://indices.edhecinfra.com/launcher>.

Our approach filters the number of assets in the infraMetrics universe to the assets that have a strong exposure to individual risk factors and a strong multi-factor intensity overall. This makes the portfolios less sensitive to the underperformance of one specific factor and enables them to benefit from a higher potential for outperformance over the long run. We apply diversified weighting scheme to diversify idiosyncratic risks and achieve the highest possible risk-adjusted return. The outcome of this approach is a “High Factor Intensity (HFI) Portfolio” that achieves high risk adjusted returns with small number of assets. Table 3 shows that a 25-asset HFI portfolio achieves higher risk adjusted returns, measured by Sharpe ratio, than both brute force portfolios built with 100 randomly chosen assets across 12 different sectors and 100 randomly chosen assets across 12 different geographies. This confirms that, by applying our *Smart Infra* approach, fund managers can achieve diversification through concentration. Using our “*Smart Infra*” approach, investors can construct portfolios that are not only theoretically viable but also practically achievable, leveraging the systematic risk factors exposure for each individual asset.

As an illustration of our “*Smart Infra*” approach, we constructed a “High Risk Factors” index, including 35 assets, that is highly diversified. Panel A of Figure 3 shows the cumulative returns time series of the HFI portfolio over the period 2009–2023 along with the broad market infra300 capital weighted index (weights capped at 5%), which tracks 300 assets in 15 sectors and 20 countries. In terms of riskiness, we observe the maximum drawdown for both indices in Panel B of Figure 3, as displayed, the HFI index exhibits less drawdowns than the infra300 index. This proves that the risk factor diversification, along with the weighting scheme, used to construct the HFI index make it more resilient to drawdowns than the infra300 index. Similarly, Table 4 shows that the HFI portfolio outperforms the market and achieves a better risk-adjusted return with 35 assets than the infra300 that has 300 assets.

#### STRATEGIC ASSET ALLOCATION: INFRASTRUCTURE IN THE TOTAL PORTFOLIO

Next, we look at what role infrastructure investments play in a multi-asset class portfolio. We construct a portfolio that includes nine asset classes, including traditional asset classes such as US equity, emerging equity, corporate bonds, government bonds, commodities, and alternative investments such as private equity, real estate, hedge funds, and unlisted infrastructure high-risk factors index. Using the infraMetrics universe of unlisted infrastructure investments, we then create Capital Market Assumptions (CMAs) for the High-Risk Factors index and measure its correlation with other asset classes. Table 5 shows that the High Risk Factors index has the highest returns and the fourth highest risk-adjusted returns (Sharpe ratio). Table 6 shows the correlation between the High Risk Factors index and other asset classes, as illustrated, has the lowest correlation with other asset classes. This demonstrates the diversification benefits the High Risk Factors index brings to a multi-asset class portfolio.

#### Building multi-asset class portfolios

We compute optimal portfolio weights for a range of risk, return and diversification targets for two profiles of investors—“conservative” and “aggressive”.

- Conservative investors follow a 20:80 strategy and allocate 20% to US equities and 80% of their portfolios to corporate bonds. This is an example of a well-funded pension plan with a focus of liability-driven investment to protect the existing fund contribution and hedge their liabilities.
- Aggressive investors follow a 60:40 strategy and allocate 60% of their portfolio to US equity and 40% to corporate bonds. Such an investor would have a higher risk tolerance and want to achieve higher returns.

TABLE 3

#### Comparison between the brute-force and risk factor diversification strategies

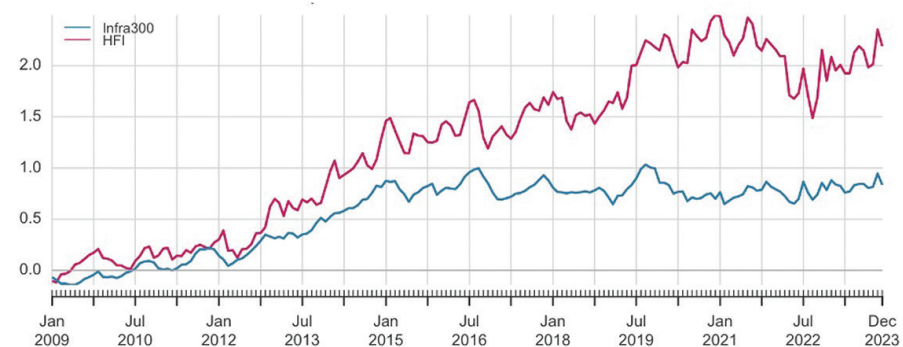
Notes: This shows a comparison between the three Brute-Force diversification strategies with 100 assets from 100 simulated portfolios and risk factor diversification based on 100 simulated portfolios of 25 assets. Results are in USD.

	100 Assets Brute-Force Strategy	100 Assets & 12 Sectors	100 Assets & 12 Countries	High Risk Factors Portfolio with 25 Assets
Annualized Return	2.91%	2.78%	2.9%	7.6%
Annualized Risk	12.7%	12.5%	12.8%	18.5%
Sharpe Ratio	0.151	0.143	0.149	0.357
[Up, Lo Bound]	[-0.023,0.325]	[-0.01,0.296]	[-0.07,0.368]	[0.173,0.540]

FIGURE 3

#### Infra300 vs HFI portfolio with 35 assets cumulative returns

Panel A:



Panel B:

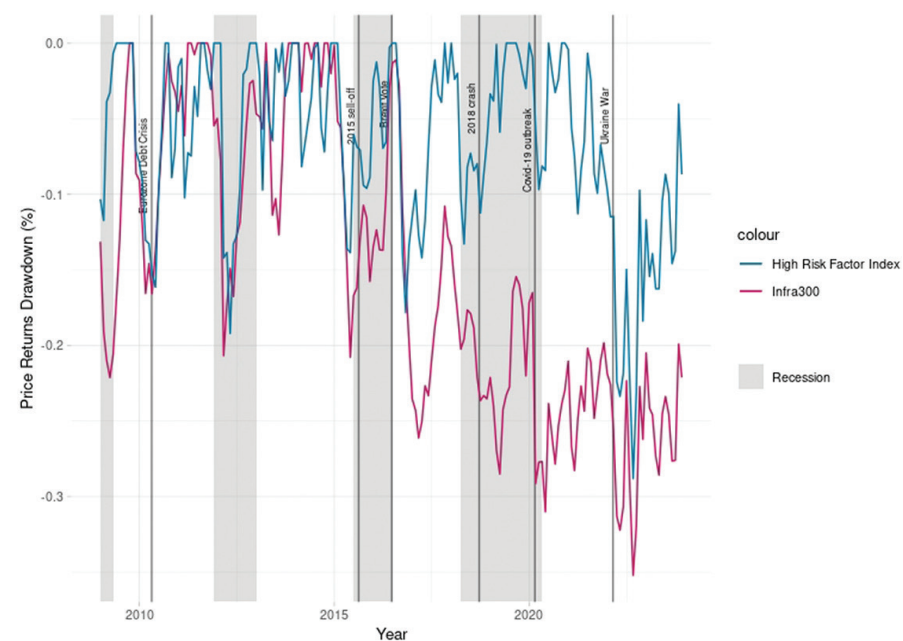


TABLE 4

#### Risk profile comparison between the infra300 index and the High Risk Factors index created through the “*Smart Infra*” approach

	Infra300	High Risk Factors Index
Annualized Return	4.1%	8.0%
Annualized Risk	10.4%	17.6%
Sharpe Ratio (rf = 1%)	0.297	0.395



TABLE 5

**Average industry expectations of risk and return across different asset classes**

Notes: The forward-looking data for asset classes with exception to the High Risk Factors are the average of the forward-looking data provided by Blackrock, JP Morgan, Morgan Stanley, BNY Mellon, Invesco, Schroders, Northern Trust, State Street, Callan and Envestnet. For the High Risk Factors index, we use the weighted average expected returns estimated by EIPA and the historical volatility based on the Smart Infra diversified weights.

Asset Class	Return	Risk	Sharpe Ratio
High risk factors index	10.03%	19.19%	0.588
US equity	6.57%	16.12%	0.408
Emerging equity	8.35%	20.21%	0.413
Corp bonds	4.58%	5.16%	0.888
Gov bonds	4.03%	4.63%	0.871
Real estate	6.54%	12.20%	0.536
Private equity	8.92%	20.83%	0.428
Hedge funds	5.37%	7.04%	0.762
Commodities	4.06%	17.32%	0.235

TABLE 6

**Correlation coefficients of the High Risk Factors index with other asset classes**

	Equity	Emerging Equity	Corp Bonds	Gov Bonds	Real Estate	Private Equity	Hedge Funds	Commodities
High Risk Factors	-0.05	-0.08	0.07	0.22	0.15	-0.05	-0.08	-0.21

TABLE 7

**Return and Risk targeting portfolio optimization techniques to build multi-asset class portfolios for Conservative and Aggressive investors**

Target	Return Target		Volatility Target		
	4.98%	5.80%	7.40%	11.80%	
	Asset Class	Conservative	Aggressive	Conservative	Aggressive
Weights	US equity	11.40%	11.80%	12.90%	19.70%
	Emerging equity	7.17%	11.29%	14.40%	26.00%
	Corp bonds	22.69%	22.90%	21.90%	12.70%
	Gov bonds	25.62%	25.50%	23.70%	10.70%
	Real estate	7.61%	6.44%	5.10%	0%
	Private equity	0%	0.95%	1.80%	8%
	Hedge funds	8.10%	2.43%	0%	0%
	Commodities	13.10%	8.40%	7.10%	10.90%
	<b>Smart Infra</b>	<b>4.40%</b>	<b>9.20%</b>	<b>13.10%</b>	<b>12%</b>
Return		5.31%	5.80%	6.10%	6.80%
Risk		6.11%	5.90%	7.40%	10.90%
Sharpe Ratio		0.706	0.717	0.69	0.537

For each, we compute two types of mean-variance optimizations, a return-targeting and a risk targeting optimization, as well as a risk-only optimization technique.

- **Return targeting:** This strategy is based on finding an allocation that achieves a portfolio return greater than or equal to the 60:40 and 20:80 portfolios, while minimizing the portfolio risk. The portfolio is fully invested, and short selling is not allowed.
- **Risk targeting:** This strategy is based on finding the optimal portfolio weights that keep the portfolio risk below the target of the 60:40 and 20:80 portfolios while maximizing returns.
- **Equal risk contribution (ERC):** This strategy is based on finding the optimal portfolio weights to minimize the risk contribution from all asset classes, while minimizing the Effective Number of Constituents (ENC).

For the first two strategies, we also apply the following two constraints:

- ENC is at least six.
- The allocation to all illiquid assets (real estate, private equity, hedge funds, commodities, risk factors indices) does not exceed 20% of the portfolio, leaving at least 80% invested in liquid assets.<sup>9</sup>

**Results**

The outcome of the different optimization techniques is shown in Tables 7 and 8, demonstrating that, across three different portfolio optimization techniques, private infrastructure can indeed play an important role in a multi-asset portfolio as a strategic asset class that complements other allocation classes.

Table 9 presents a comparison of Sharpe ratios across different portfolio strategies with and without infrastructure. The portfolios that incorporate infrastructure assets consistently achieve higher Sharpe ratios. This confirms the positive role that infrastructure can play in the portfolio.

**CONCLUSION**

To conclude, the Smart Infra approach described in this paper makes diversification of unlisted infrastructure investments feasible within portfolios. Hundreds of bets can be necessary to build a portfolio with fully diversified idiosyncratic risks unless these assets are selected based on their risk-factor exposures. Trying to add decorrelation to the portfolio by adding more assets in different sectors and countries ignores the fact that investments are not only linked by sectors and countries but also by their risk profile as a business i.e., the risk factors described in this paper. These risk factors are universally available in all assets because they represent the systematic risk that the market prices in these assets. This universal availability enables investors to access exposure to these factors much more easily than sector and country bets.

Defining a diversification strategy as “We need to add 20 new transport investments in 10 different countries to the portfolio” is a non-starter for any deal team. Instead, “We need to add 10% of exposure to the size factor to the portfolio” is relatively easily implemented.

The principles of risk factor diversification illustrated here demonstrate that in private markets, where investors are restricted to holding a limited number of assets, they can still achieve diversification through concentration. Our approach is not limited to unlisted infrastructure equity alone but can be extended to other illiquid asset classes such as infrastructure debt, real estate, and private equity. By applying similar strategies, investors can leverage the benefits of systematic risk factor exposure to achieve more efficient diversification, thereby enhancing portfolio performance and mitigating idiosyncratic risks across a broader range of investments.

<sup>9</sup> The choice of 20% is ad hoc but consistent with average allocations for some large institutional investors such as US public pension funds.

TABLE 8

**ENC Target portfolio optimization techniques to build multi-asset class portfolios for Conservative and Aggressive investors**

	Asset Class	High ENC Target	Mid ENC Target	Low ENC Target
<b>ENC Target</b>		<b>7</b>	<b>6</b>	<b>5</b>
Weights	US equity	14.1%	10.4%	7.4%
	Emerging equity	11.8%	7.7%	5.4%
	Corp bonds	19.3%	24%	24.1%
	Gov bonds	19.6%	26%	33.8%
	Real estate	5.2%	5.5%	6.3%
	Private equity	3.7%	3.1%	3.5%
	Hedge funds	5.1%	5.3%	5.3%
	Commodities	15.2%	15.2%	10.5%
		<b>Smart Infra</b>	<b>5.9%</b>	<b>6.2%</b>
Return		5.7%	5.5%	5.3%
Risk		7.6%	6.3%	5.4%
Sharpe Ratio		0.621	0.714	0.793

TABLE 9

**Sharpe ratio comparison across portfolios with high risk factors index and without infrastructure assets.**

Notes: Sharpe ratio is calculated based on 1% risk free rate. All calculations are in USD.

	Return Targeting		Risk Targeting	
Allocation	20/80	60/40	20/80	60/40
Portfolio w/ High Risk Factors	0.706	0.717	0.690	0.537
Portfolio w/o Infra	0.668	0.631	0.640	0.483

## REFERENCES

- Amenc, N., F. Blanc-Brude, Q. Goh, A. Gupta, B. Jayles, L. Lum, N. Manocha, and D. Marcelo** (2023). *It's getting physical: some investors in infrastructure could lose more than half of their portfolio to physical climate risks by 2050*. Technical report, Scientific Infrastructure & Private Assets Research Institute.
- Amenc, N., F. Blanc-Brude, A. Gupta, and T. Whittaker** (2022). *An infrastructure investment primer: From valuation to allocation and manager selection*. *The Journal of Portfolio Management*, 48(9), 117–202.
- Blanc-Brude, F. and C. Tran** (2019). *Which factors explain unlisted infrastructure asset prices? evidence from 15 years of secondary market transaction data*. Technical report, Scientific Infrastructure & Private Assets Research Institute.
- Chen, Y. and K. Tsang** (2013). *What Does the Yield Curve Tell Us about Exchange Rate Predictability?* *The Review of Economics and Statistics*, 95(1), 185–205.
- Fama, E. F. and K. R. French** (1993). *Common risk factors in the returns on stocks and bonds*. *Journal of Financial Economics*, 33(1), 3–56.

# PECCS®

## THE PRIVATE COMPANY CLASSIFICATION STANDARD

A multi-dimensional scheme considering industrial activity, lifecycle phase, revenue model, customer model, and value chain type. This classification aids in creating peer groups for better insight into private companies.

# EDHEC Private Assets Day

October 17, 2024

Convene, 311 West Monroe Street, Chicago



The Only Event on Quantitative Research  
and Private Markets