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RESEARCH INSIGHTS | EDHEC BUSINESS SCHOOL

EDHEC*infra* & Private Assets

Contents

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Introduction

I am delighted to introduce the infrastructure investment special issue of the EDHEC Infrastructure & Private Assets Research Institute Research Insights supplement to Investment & Pensions Europe, which aims to provide institutional investors with an academic research perspective on one of the most pressing issues facing them today.

We first look at the use of data to produce a benchmark or comparable ('comp') of the climate risks of infrastructure companies. Few data points are available for comparable assets and a typical 'comparable' can look very ad-hoc and unrepresentative if it is based on fewer than a dozen data points. We discuss EDHEC*infra* & Private Assets data that is both granular and robust.

We then present a model that intertwines financial and macro-economic variables with Network for Greening the Financial System (NGFS) scenarios to make asset-level, scenario-dependent projections until 2050 of financial indicators such as revenues, profits, discount rates and valuation.

We summarise the findings of a new paper in which we examine the public's sentiment toward wind power generation in the United States and the United Kingdom. Monitoring public attitudes towards infrastructure sectors is necessary to detect changes in public opinion, intervene promptly and ensure projects can develop without interruptions. However, monitoring public opinions remains a challenge. Our study applies Natural Language Processing (NLP) techniques to analyse various text sources and to provide the infrastructure industry with novel social acceptance indices that indicate public support and social risk factors.

Finally, we present a new study by EDHEC*infra* & Private Assets, which indicates that $1.6trn of the European infrastructure asset class (European Economic Area and the UK) by size is likely to qualify as sustainable under the EU Taxonomy for Sustainable Activities, while only $10bn of assets by size is likely to have no sustainable characteristics and could be stranded in the transition to a low-carbon economy. An additional $235bn of infrastructure is not aligned with the EU taxonomy's definition of sustainability.

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

Frédéric Blanc-Brude, Director, EDHEC*infra* & Private Assets

TCFD: Where are your 'climate comps'!?

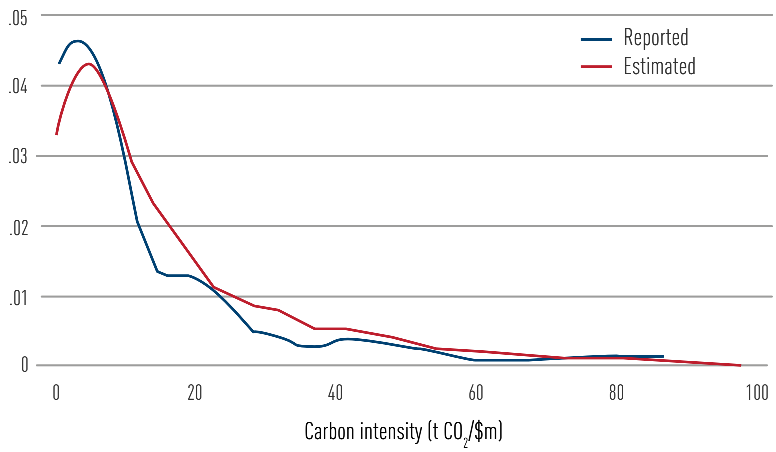
Darwin Marcelo, Project Director, EHDEC*infra* & Private Assets

As the Task Force on Climate-related Financial Disclosures (TCFD) deadlines loom, many infrastructure asset managers are still looking for the data they need to report the carbon intensity of their investments. That's because the data has either been not very forthcoming or not very good (even if you prefer to ignore Scope 3). If this feels familiar, it is because getting the right data was always going to be difficult. Carbon emissions are not like financials, which can be sourced back to individual invoices. Carbon molecules cannot be counted as they float away and estimating emissions either requires an in-depth asset-level investigation or is going to boil down to using a proxy of some sort.

Asset-level assessments are costly, and, in the end, they also rely on proxies (there is no little man counting the CO_2 particles being released in the atmosphere). A line-by-line carbon assessment of a decent infrastructure portfolio can quickly cost millions of dollars and take many months. TCFD allows proxies to be used, but not all proxies are convincing enough. This is a familiar problem in private markets: few data points are available for comparable assets and a typical 'comparable' can look very ad-hoc and unrepresentative if it is based on fewer than a dozen data points.

But there is a better (and cheaper) way. EDHEC*infra* & Private Assets has put in a lot of effort to produce data that is both granular and robust and can be used as a benchmark or comparable of the climate risks of infrastructure companies.

1. Reported versus estimated carbon intensity in EDHEC*infra* & Private Assets data (Scope 1)



Source: author's calculations, infraMetrics

Carbon model pageant

We have collected hundreds of reported carbon emissions by different types of infrastructure companies all over the world and in each segment and subsegment of the TICCS (The Infrastructure Company Classification Standard) taxonomy. Using this data, we have built and calibrated technology-specific models of the carbon emissions of these infrastructure assets.

Did you know that the shape and volume of airport terminal buildings can be used to partly predict their Scope 2 emissions? The 'rounder' the building, the more energy efficient it is. Nooks and crannies are not good for your carbon footprint. Because we have compiled the physical shape of thousands of airports in the world (this is useful for physical risk assessments, more on that below), we know the shape of the terminal building of all the airports that report their emissions, and of those that do not. Likewise, a handful of factors, traffic, outside temperature and temperature variability, etc, explains and predicts the bulk of the emissions of a typical road, data centre or port.

When we compare our model's performance with the reported data, we see that there are indeed a number of factors that systematically explain the emissions that infrastructure companies report (following the correct GHG protocol) – see figure 1 for Scope 1 emissions. The average error of the models is close to zero. Of course, individual assets differ from the average (and the model) but to build comps at the segment level, this is very effective.

We produce estimates for Scopes 1, 2 and 3, using a range of techniques, from the purely stochastic to physical models (counting planes and ships). Using this technology, a growing body of reported data and well-calibrated sector and subsector models, we generate carbon estimates for thousands of infrastructure companies, making our 'carbon comps' very robust statistically, yet granular to the investor in specific assets (see figure 2). All this at a fraction of the cost of a line-by-line asset-level carbon audit.

It's getting physical

TCFD also requires knowing "the amount and extent of assets or business activities vulnerable to physical risks". This is trickier because it really requires asset-specific data. We have collected data not only for the shape but also the makeup of hundreds of infrastructure assets and associated them with different hazard models and damage functions (see figure 3) to create a dataset of 'damage factors' for the most important hazards for infrastructure assets (floods, storm, and heat). Combined with financial data, this allows the physical risk value at risk and expected losses to be computed today (the baseline).

But can this be used to proxy the physical risks of assets in investors' portfolios? To some extent it is possible to generalise, for example by taking regional and technical features into account, eg, number of runways for an airport, number of turbines. Still, asset-level geo-data remains essential to answer these questions more precisely. Investors need to decide how robust (and costly) they want their TCFD physical risk assessments to be.

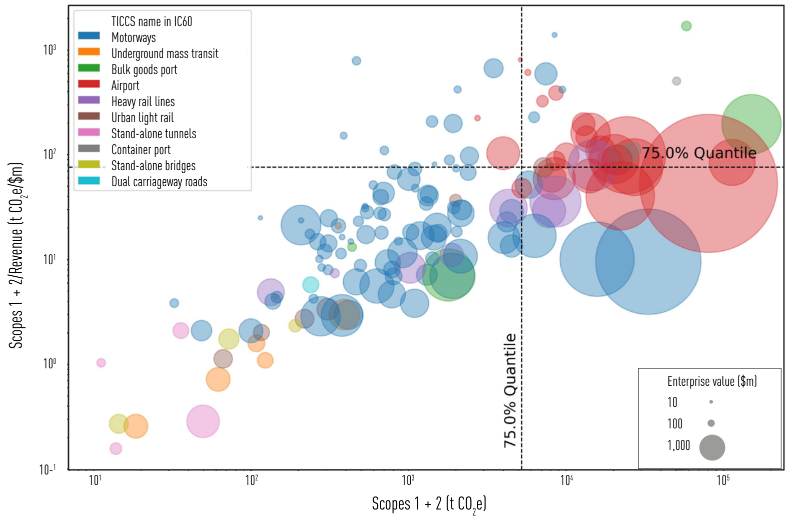
Beyond the baseline

Climate risk assessments are only a starting point: beyond today's baseline, investors need to know plans for what climate change might bring in terms of lost revenues, lower profits, higher capex and more. For this, we all use a range of climate scenarios. Independently of the preference taken for one scenario or another, the starting point or baseline from which the scenario is to be applied to estimate either transition risk (usually proxied by a rapid change in carbon taxes) or physical risk (the asset-level and economy-wide damage caused by extreme weather events) is an all-important data point.

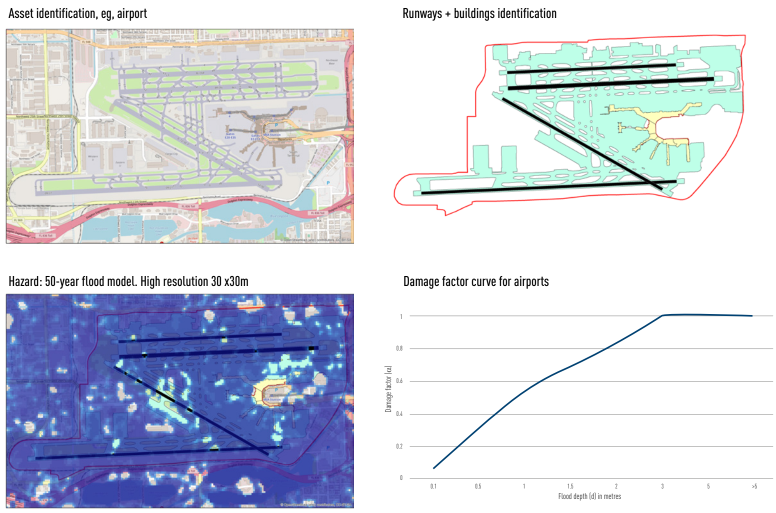
This is probably why getting your TCFD comps right matters the most today. Not so much that they have to be 'right' for the sake of reporting the correct number, but they are also the main input in your future climate risk assessment and will determine the quality of the risk estimates.

Just like we have used comps for financial analysis for decades, it makes sense to adopt similar approaches for climate risks, but we need to make sure to use the best data, large and granular data sets, and robust models. Do not hesitate to ask your consultant to demonstrate that their model is robust!

2. Carbon intensity and asset size (Scopes 1 and 2)



3. Approach to estimating asset-level physical risks: floods in airports



Including climate risks in infrastructure asset valuation:

A data-driven modelling approach

Bertrand Jayles, Senior Sustainability Data Scientist, EDHEC*infra* & Private Assets; **Abhishek Gupta**, Associate Director, EDHEC*infra* & Private Assets; **Tim Whittaker**, Research Director, EDHEC*infra* & Private Assets; **Frédéric Blanc-Brude**, Director, EDHEC*infra* & Private Assets

In this paper we show how it is possible to include climate risks in the projections of the value of infrastructure companies at the horizon 2050, under several climate scenarios.

Introduction

Climate change is one of the most pressing challenges facing humanity today, with potentially severe implications for infrastructure assets. Infrastructure investments such as roads, bridges, ports, airports and power plants have long lifetimes, typically spanning several decades, and are designed to operate under specific climatic conditions. However, climate change is causing more frequent and intense extreme weather events, such as floods, droughts, heatwaves and storms, which can damage or disrupt infrastructure assets. These physical risks can lead to direct losses, increased maintenance costs and lower asset values. Beyond physical risks, climate change also generates transition risks, such as changes in policy, technology and consumer preferences that can impact the value of infrastructure assets. It is thus essential for infrastructure investors and other stakeholders to take climate risks into consideration when evaluating the future value of infrastructure assets. Making the economy of those could lead them to poor and high-risk decisions. Comprehensive methodologies for assessing climate risks in infrastructure asset valuation are still lacking. This article marks an important step forward in this direction: building on previous work, we develop a model that intertwines financial and macro-economic variables with Network for Greening the Financial System (NGFS) scenarios to make asset-level, scenario-dependent projections until 2050 of financial indicators such as revenues, profits, discount rates and valuation.

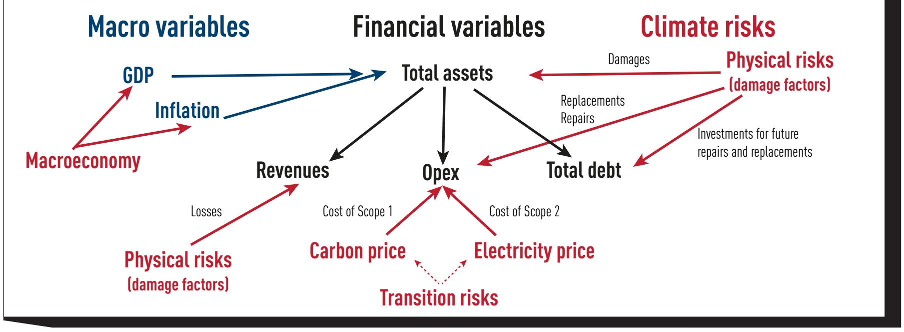
General approach

Building on previous work (Alogoskoufis et al [2021]), we first model the relationship between key financial variables in infrastructure companies (total assets, revenues, operating expenses) and macroeconomic variables (GDP, inflation). Our equations are recursive, such that variables at time t depend on the same and/or other variables at time t−1. We assume that total assets follow an auto-regressive pattern, and that their growth is correlated with GDP growth and inflation. In the infrastructure sector, we expect revenues of corporate companies to correlate with total assets. Likewise, operating expenses (opex) are expected to grow with the size (total assets) of the business. We thus regress the growth of revenues and opex against the growth of total assets. Figure 1 illustrates these dependencies. Note that the effects of GDP and inflation on revenues and opex are reflected through their effects on total assets.

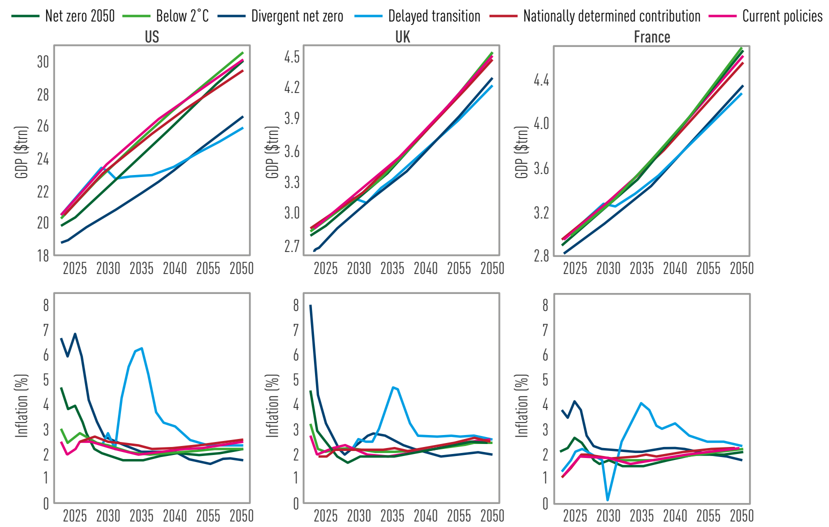
After calibrating these equations, assuming that the relationships between financial and macroeconomic variables hold in the future (until 2050 at least), we are thus able to project financial variables over time, provided that we have projections of GDP and inflation. This is where the NGFS comes into play, by providing the latter for six distinct climate scenarios (the so-called 'NGFS scenarios') with different levels of expected climate risks. On top of macroeconomic forecasts, expected damages (physical risks) and

1. Illustration of the functioning of the climate risk model

The effects of GDP and inflation on revenues, opex and total debt are reflected through their effects on total assets.
The effects of physical and transition risks are depicted in red.



2. NGFS projections of GDP and inflation in all scenarios, for three major economies by EDHEC*infra* & Private Assets: US, UK, France



additional costs related to the price of carbon and electricity (transition risks) must be considered when forecasting financial variables. Damages will negatively affect total assets and subsequently revenues (loss of production capacity) and increase the operating expenses through additional repair and replacement costs. On the other hand, carbon taxes to limit climate-related damages will increase the price of carbon and electricity, and thereby companies' operating costs. All these effects are depicted in red in figure 1. Dedicated teams at EDHEC*infra* & Private Assets are in charge of estimating asset-level carbon emissions and expected damages. We assume that Scope 1 and 2 emissions grow at the same rate as global emissions (per country), provided by NGFS. Likewise, we get projections of carbon and electricity prices from NGFS. As for physical risks, we assume that they grow at a rate consistent with literature on floods and other risks.

We project the total debt of companies by assuming that they keep the same capital structure over time. Total debt thus follows the growth rate of total assets. However, companies need to raise funds to cover potential future damages to total assets. Total debt thus grows faster than total assets, leading to increasing leverage. From the knowledge of total assets, revenues and opex, we can also project the profits of firms. Overall, we are thus able to generate time series until 2050 of six key financial variables (total assets, revenues, operating expenses, total debt, leverage and profits), which are then used as inputs of EDHEC*infra* & Private Assets' asset pricing models to produce asset-level financial indicators such as discount rates, dividend and valuation.

Data

Financial data: infraMetrics
InfraMetrics comprises data for 7,608 companies across 33 countries worldwide. The core of our model involves linear regressions (see below [OK?]) which require historical data on total assets, revenues and opex. After excluding data anterior to 2000 we have:

- Total assets: 44,584 observations across 5,589 companies and 25 countries;
- Revenues: 22,915 observations across 3,045 companies and 25 countries;
- Opex: 10,667 observations across 819 companies and 24 countries.

Macroeconomic data: World Bank and NGFS-NiGEM
For its calibration part, we feed our model with GDP and inflation data from the World Bank. For its projection part, we use climate scenario projections of the same macroeconomic variables, provided by the NiGEM model in the NGFS database.

Figure 2 shows the projections of GDP and inflation for three major economies tracked by EDHEC*infra* & Private Assets: US, UK and France. Green, blue and red are used for orderly, disorderly, and hot house world scenarios, respectively. We see that economies continue growing relatively fast in all scenarios. Differences between scenarios exist, however, with GDP being significantly lower in the disorderly scenarios (blue lines) than in other scenarios. Similarly, inflation is particularly affected in disorderly scenarios (blue lines), highlighting the inflationary effects of stringent carbon policies. In the absence of compelling climate policies (hot house world scenarios: red lines), inflation is projected to remain relatively stable over time.

Emissions data: transition risks
One measure commonly undertaken to mitigate carbon emissions is to increase their price through a carbon tax. Such a tax directly affects the price of Scope 1 emissions through the price of carbon, and indirectly the price of Scope 2 emissions through the price of electricity (itself affected by the price of carbon). These two aspects translate into operating costs that we include in our model. We thus need, in order to project these costs, projections of Scope 1 and 2 emissions, as well as projections of carbon and electricity prices. While the latter are provided by NGFS, a dedicated EDHEC*infra* & Private Assets team is in charge of calculating various metrics of carbon emissions at company level, Scope 1 and 2 in particular (Nugier and Marcelo [2022]). To project these emissions into the future, we assume that Scope 1 and 2 emissions grow at the same rate as global emissions (per country), provided by NGFS as well.

Damage data: physical risks
Another dedicated team at EDHEC*infra* & Private Assets is in charge of estimating the impact of climate change-driven hazards on physical assets. This impact is quantified, for any single company, by a damage factor D, which represents the fraction of the area covered by the company that would be 'destroyed' upon the occurrence of a given hazard. Damage factors are calculated from the probability of occurrence and the intensity of various hazards in the zone where a firm is located. As of now, our calculations integrate floods, storms and cyclones as 1 in a 100-year event. That is, the probability of their occurrence is $\rho = 1\%$. Importantly, D and ρ are calculated as of today, and are thus not scenario- or time-dependent. They are, however, expected to change (and likely increase) in scenarios where efforts to mitigate climate change are insufficient.

NGFS scenarios assume that climate goals are met (ie, physical risks are mitigated, and the temperature rise remains below 2ºC) in the orderly and disorderly scenarios. Following this assumption, we thus assume that D and ρ remain constant in those four scenarios. In the hot house world scenarios, however, climate goals are not met, and the global mean temperature increase is expected to exceed 3°C in the current policies scenario, and to be about 2.6°C in the NDC scenario (NGFS [2022]). Recent research has shown that river flood damage in Europe could rise by a factor of about 6 ± 2 by the end of the century, in the absence of climate mitigation (ie, an expected 3°C GMT increase – Dottori et al [2023]). This is consistent with a growth of about 2.3 ± 0.5% per year until 2100. Consistently with these numbers, we thus assume that D and ρ grow by 2% per year in the NDC scenario (2.6°C GMT increase), and 2.5% in the current policies scenario (3.2°C GMT increase).

Key results and conclusions

Our approach allows time series of six key financial variables to be derived: total assets, revenues, operating expenses, total debt, leverage, profitability (figure 3). Our results consistently show a downtrend in profitability in all scenarios, indicating that the implications of climate change on infrastructure companies are unavoidable. While the amplified intensity and frequency of hazard events (physical risks) will increase the costs of companies through maintenance and repairs, carbon taxes to limit these risks will increase the cost of companies' carbon emissions (transition risks). However, scenario analysis suggests that this downward slide can be partially mitigated if immediate and coordinated action is taken by companies and governments alike (orderly scenarios). Any delay in response (delayed transition), or a lack of coordination (divergent net zero) in implementing sustainable practices will lead to transition costs that can be hard to bear, in fossil-fuel reliant sectors in particular. On the other hand, inaction (hot house world scenarios) is not a viable alternative: while it may hold off the transition costs in the near term, it will undoubtedly result in exorbitant costs in the longer run due to amplified physical damages and insurance premia.

The above financial variables are then injected into the EDHEC*infra* & Private Assets asset pricing model to produce asset-level financial indicators such as discount rates, dividend and valuation. Knowing the values of infrastructure assets at different horizons in the six NGFS scenarios gives us the opportunity to compare projections across scenarios and thus derive metrics of climate risk. In particular, the difference in valuation between scenarios gives us measures of the potential losses incurred from transition or physical risks:

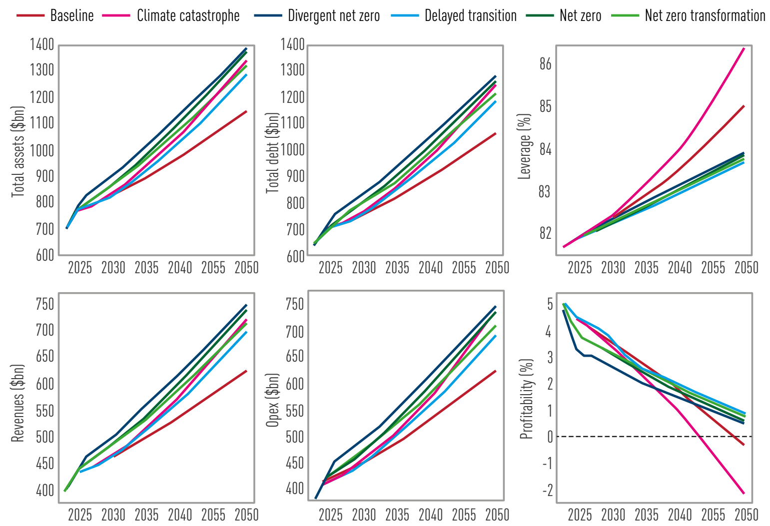
- *Extreme macro risk:* difference in the valuation of a company between the current policies scenario (lowest transition risks) and the delayed transition scenario (highest transition risk).

While this metric, which compares two scenarios, gives a sense of the impact of making certain climate decisions or not, it forbids a direct comparison of transition and physical risks, since both are included together with a given scenario projection. To isolate and better compare the effects of either transition or physical risks, we can switch on or off the corresponding exposure terms in our model, within a given scenario:

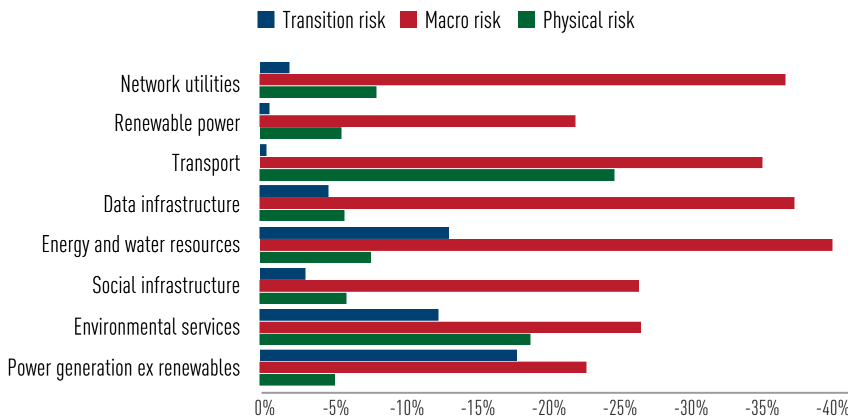
- *Extreme physical risk:* within the current policies scenario (highest physical risks), difference in the valuation of a company between the case when both physical and transition risks exposures are switched off, and the case when only transition risks exposures are switched off.
- *Extreme transition risk:* within the delayed transition scenario (highest transition risks), difference in the valuation of a company between the case when both physical and transition risks exposures are switched off, and the case when only physical risks exposures are switched off.

We can then look at the distribution of this metric across sectors (figure 4).

3. We derive six key financial variables: total assets, revenues, operating expenses, total debt, leverage and profitability



4. Extreme climate risks in infrastructure sectors



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Social acceptance analysis using social media:

Using Twitter data to measure sentiment about infrastructure sectors

Jeanette Orminski, Senior Sustainability & ESG Researcher, EDHEC*infra* & Private Assets; **Jianyong Shen**, Senior Research Engineer, EDHEC*infra* & Private Assets

This article summarises the findings of a new paper in which we develop social acceptance indices and examine the public's sentiment toward wind power generation in the United States and United Kingdom (Orminski and Shen [2023]).

Efficient infrastructure networks bring essential public services to communities, including electricity, transport and water. However, infrastructure projects can also create significant disruptions, such as loss of amenities, increased noise, air and water pollution, or impacts on local wildlife and human health. These adverse effects may lead to negative sentiments and reduced public support, resulting in delays or even cancellations of infrastructure projects. Studies have shown that opposing movements from residents or environmental groups are a significant factor in infrastructure projects being cancelled, delayed and more expensive. Accordingly, monitoring public attitudes toward infrastructure sectors is necessary to detect changes in public opinion, intervene promptly, and ensure projects can develop without interruptions.

However, monitoring public opinion remains a challenge. Traditional approaches, such as public opinion surveys, require time, money and human resources and primarily focus on a broad acceptance level rather than including the communities' or markets' perspective. With the growth of social media, people have more opportunities to share their opinions online with a wide audience. This trend provides research with alternative approaches to measuring public opinion and social acceptance in written texts people share online (for example, posts on social media platforms such as Twitter, reviews on Google or forum discussions on Reddit). Our study applies Natural Language Processing (NLP) techniques to analyse various text sources and to provide the infrastructure industry with novel social acceptance indices that indicate public support and social risk factors.

Social acceptance

When analysing social support for infrastructure projects, most studies focus on the level of social acceptance. In comparison to *social acceptability*, which describes a dynamic process influenced by individual attitudes, inter- and intrapersonal evaluations, and perceptions of involved stakeholders, circumstances and the broader economic and political situation, *social acceptance* is the positive result of the acceptability process and can change over time (Busse and Siebert [2018]).

Wüstenhagen et al (2007) divide the concept into three types of acceptance to refer to different interest groups: the broad socio-political acceptance of policies and new technologies by the public, the local community acceptance that represents those directly affected by siting decisions around infrastructure assets, and consumers' and investors' market acceptance reflected in demand and investments made in new technologies and infrastructure assets. Often, the public's socio-political acceptance of an infrastructure asset can be high, while the community acceptance of a specific project and the market acceptance remain low.

We apply the sentiment analysis method to measure social acceptance across various infrastructure sectors in an immediate and relatively cost-effective way. Algaba et al (2020, 547) define sentiment in this context as "the disposition of an entity toward an entity, expressed via a certain medium". In our case study, the entity of positive and negative expressions from residents in the UK and US serves as a proxy to measure the entity of social acceptance toward wind power generation. Textual data from the social media platform Twitter serve as a medium.

EDHEC*infra* & Private Assets' social acceptance indices

Based on the analysis, we built indices that serve as tools to monitor changes in sentiment over time, across countries, and for different infrastructure sectors. Currently, we provide social acceptance indices for five countries, covering 23 infrastructure sector groups over a period of seven to 10 years.

- The Social Support Index measures the public's social acceptance of an infrastructure sector:

$$\tilde{s}(T) = f_s(T) + \sum_k \beta_k x_k(T) + \varepsilon(T) \quad (1)$$

$$f_s(T) = f_s(T-1) + \eta(T) \quad (2)$$

where:
$\tilde{s}(T)$ is the averaged tweets' sentiment score at time T,
$f_s(T)$ is the systematic effect at time T and has the random movement $\eta(T)$,
β_k and $x_k(T)$ are the k-th idiosyncratic effect and averaged feature of the tweet at time T, and
$\varepsilon(T)$ is the observed noise at time T.

Both signal $\eta(T)$ and noise $\varepsilon(T)$ follow a random walk of normal distribution

$N(0,\sigma_\eta)$ and $N(0,\sigma_\varepsilon)$, respectively.

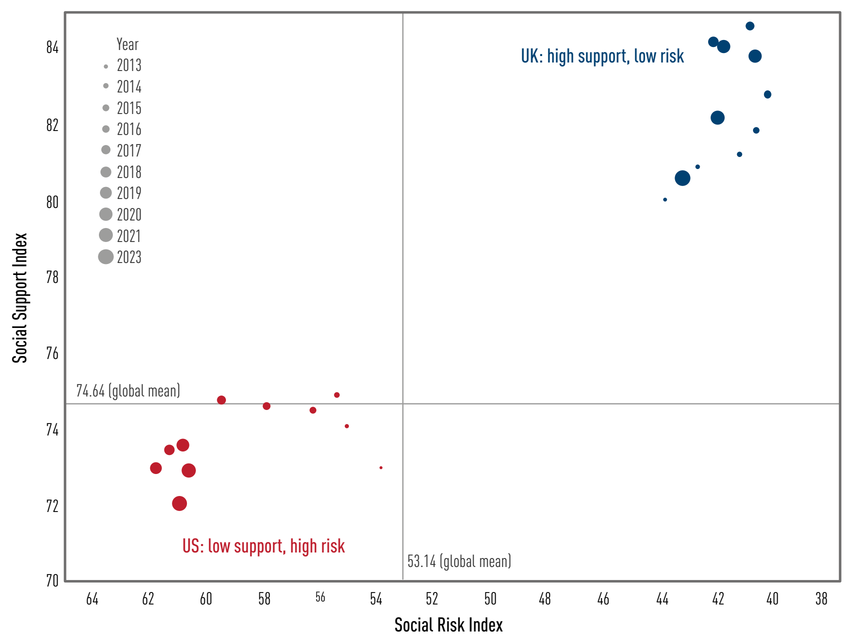
We use the Kalman filter in the Space-State model to smooth the values of the systematic effect $f_s(T)$ (denoted as $\tilde{f}_s(T)$) and apply a scaling function to transform the index to a range from 0 to 100 for better readability of the overall support of the public.

$$index(T) = \frac{A}{1+\exp\left(k\left(\tilde{f}_s(T)-b\right)\right)} - F \quad (3)$$

index (*T*) represents the Social Support Index directly and measures the public's social acceptance toward an infrastructure sector.

- The Social Risk Index measures the level of disagreement within the public and represents risk factors for investors, regulators, and the sector stemming from polarising oppositions. To compute the Social Risk Index, we split the data at the median sentiment score into two groups and calculate the *index* (*T*) as $index_{up}$ (*T*) and $index_{low}$ (*T*). The difference between $index_{up}$ (*T*) and $index_{low}$ (*T*) builds the Social Risk Index and represents the level of disagreement within the public.

1. Social Support and Social Risk indices for the US and UK



Use case: wind power generation in the US and UK

What data did we use?
To analyse the Twitter discourse on wind power generation, we applied EDHEC*infra* & Private Assets' Sector and ESG Dictionaries[1] to identify relevant tweets that discuss onshore and offshore wind power generation in an ESG context (eg, environmental impacts, noise pollution, waste management, working conditions). We used the Twitter API to collect tweets in English between January 2013 and March 2023 from users residing in the US (n = 57,651) and UK (n = 31,048).

How did we measure the sentiment?
To determine the sentiment of each tweet, we followed the lexicographic approach (Shapiro et al [2022]). Specifically, we employed the VADER dictionary that Hutto and Gilbert (2014) developed for short social media texts. The dictionary provides a sentiment value (between –4 and +4) for each word in a text. Based on the sum of the sentiment value, VADER computes a normalised sentiment compound score between –1 and +1, indicating a tweet's sentiment polarity (positive or negative) and intensity. In comparison to other lexicographic approaches, the VADER dictionary includes words, lexical features (eg, emojis, slang used on social media, sentiment-related acronyms, like LOL, WTF) and heuristics that incorporate word-order sensitive relationships and influence the polarity and intensity of the sentiment.

What are our key findings?
Overall, social acceptance towards wind power generation is higher in the UK than in the US (figure 1). Several policy changes and initiatives in the UK aimed to promote renewable energy sources, and may have contributed to the positive and agreeing sentiment trend (represented by high social support and low social risk indices). On the other hand, polarising opinions, opposing political camps and different regulatory strategies within the country determine the sentiment in the US. While public support for wind power generation has been relatively stable over the past 10 years, the Social Risk Index remains increasingly high and reflects the polarisation in the country. Generally, a higher Social Support Index is accompanied by a lower Social Risk Index and vice versa (figure 2).

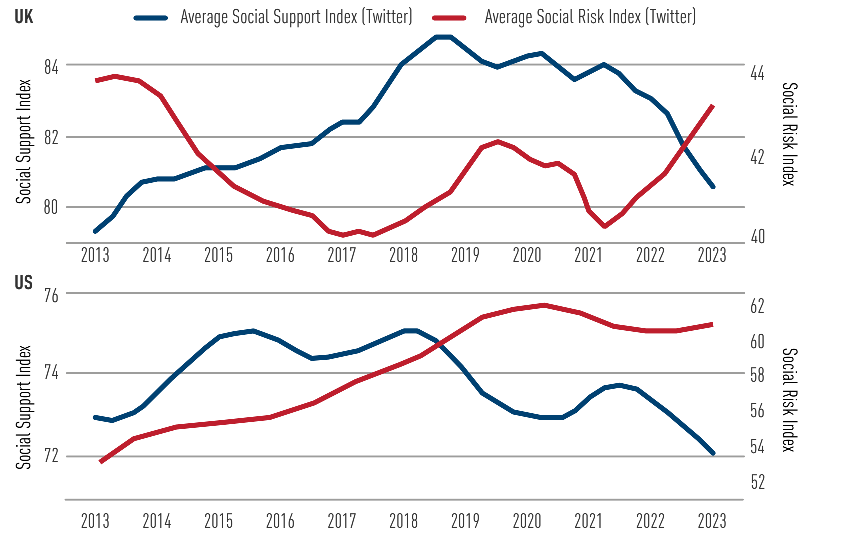
Are our results robust?
In order to validate the sentiment results and to test whether they can be used as proxies for social acceptance, we compared our results to previous sentiment analyses using news articles (Shen and Whittaker [2023]) and public opinion surveys.

Overall, the Social Support Index follows the public opinion survey trends:

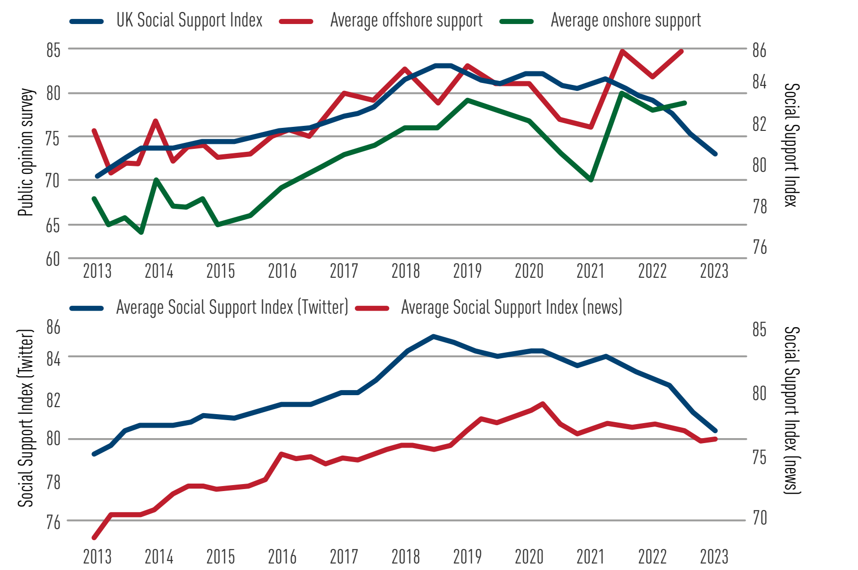
- In the UK, the Social Support Index closely follows the results of the BEIS Public Attitudes Tracker measuring support for onshore and offshore wind power (figure 3). The survey is updated bi-annually and has not been updated for 2023. Similarly, the Twitter index follows the same trend as the Social Support Index using news data. However, the Twitter discourse seems to be more positive than the news coverage on wind power generation.
- The US conducts fewer public opinion surveys with a less consistent methodology. Accordingly, the results present a less clear picture of the relationship between the sentiment index and the survey results. However, public opinion seems to follow the same but time-delayed trend as the Twitter sentiment, which may be due to the time-consuming procedures of conducting representative surveys (figure 4). In comparison to the UK, the Twitter sentiment in the US is more negative than the news sentiment for most periods. Considering that the news' primary objective is to inform the public and to report from a neutral perspective, it is not surprising that the Twitter sentiment

1 Both dictionaries were developed in line with EDHEC*infra* & Private Assets' infrastructure taxonomy TICCS (EDHEC*infra* & Private Assets [2022]) and the ESG Taxonomy of Impacts and Risks for Infrastructure Companies (Manocha et al [2022]).

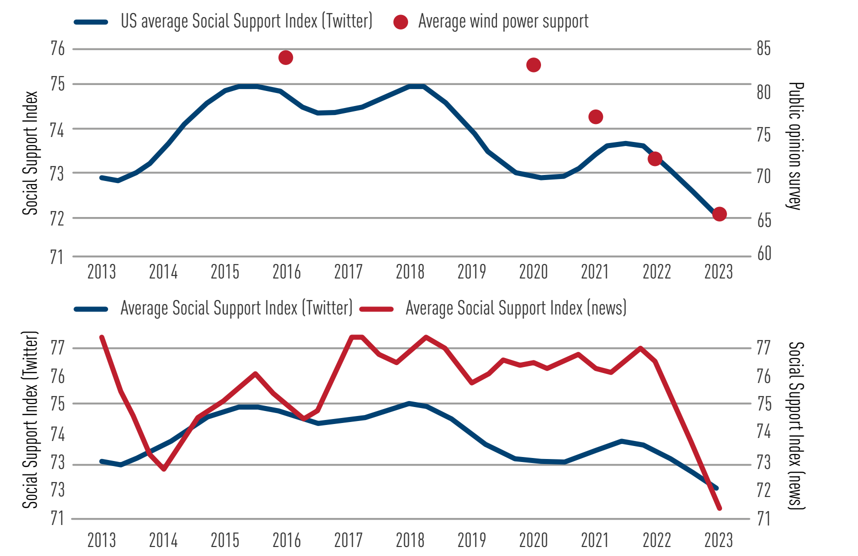
2. Social Support and Social Risk indices for the US and UK



3. Validating the Social Support Index in the UK



4. Validating the Social Support Index in the US



trend is more extreme (in either direction) than the news sentiment trend.

- Differences in news coverage can explain the converse sentiment results in the US and UK. For example, when reporting on the same issue, journalists in the US report more from perspectives of patriotic values and governmental support. In contrast, journalists in the UK often follow a more critical perspective emphasising consequences for the people (Wahl-Jorgensen and Hanitzsch [2009]).
- The results show a correlation between the sentiment index trends and other measures of public acceptance, concluding that our methodology can be used to measure social acceptance effectively and efficiently. This conclusion varies slightly between the UK and the US and the two validation approaches. It needs to be considered that the survey results can only provide a guideline to validate rather than generalise the findings. Furthermore, results from the news sentiment represent social acceptance as provided in the (presumably balanced) news reporting that may not reflect public opinion as polarised and extreme as it might occur in those countries. With those caveats on the validation, it is encouraging that the results of the BEIS Public Attitudes Tracker, the survey with the most consistent questionnaire design, correlate well with the sentiment index constructed for the UK and hence, validate the social acceptance indices as reliable measures of social acceptance.

In conclusion, the study emphasises the importance of understanding public sentiment to ensure timely intervention and successful project completion. As a result, policymakers, infrastructure developers, and investors can use the social acceptance indices as tools to identify declining social acceptance early, develop effective communication strategies and engage with the public to manage risks and adjust and diversify investments across various sectors, regions, and social risk levels.

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European infrastructure assets and the EU green taxonomy

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This article summarises a new study by EDHEC*infra* & Private Assets, which indicates that $1.6trn of the European infrastructure asset class (European Economic Area and the UK) by size is likely to qualify as sustainable under the EU Taxonomy for Sustainable Activities, while only $10bn of assets by size is likely to have no sustainable characteristics and could be stranded in the transition to a low-carbon economy. An additional $235bn of infrastructure is not aligned with the EU taxonomy's definition of sustainability.

New documentation from the European Commission clarifies that EU investments in taxonomy-aligned 'environmentally sustainable' economic activities can be automatically qualified as 'sustainable investments' in the context of the product-level disclosure requirements under the SFDR (EU Commission [2023]). Using EDHEC*infra* & Private Assets' infrastructure universe dataset, which is representative of the European infrastructure asset class, we thus estimate that 88% of infrastructure investments by size can potentially be sustainable investments.

Why EU taxonomy alignment matters for assets

The aim of the EU taxonomy is to help investors identify sustainable investments, to avoid misrepresentation of sustainability (a practice often described as 'greenwashing') and to facilitate investment in the transition to a sustainable, low-carbon economy. It can therefore have considerable influence on the perception and approach to assets in the EU, including infrastructure and investment products that include infrastructure assets.

Classification of an investment as sustainable is likely to offer advantages for an infrastructure asset. Green investments often provide access to public sector financial incentives, such as cash grants, soft loans and tax incentives, as well as private sector loans that are easier to access and may have more favourable terms than market standards. Classification as sustainable may also indicate a lower technology risk in transitioning the asset to a net-zero operation that is compatible with many countries' long-term climate policy objectives. Any accelerated rate at which finance can be acquired for these sustainable asset classes could therefore be expected to drive their growth and contribute to the transition to a sustainable economy.

If an asset fails to be classified as sustainable under the EU taxonomy, this could be a sign of sustainability risk. At the very least, it is likely that such assets will be excluded from green finance mechanisms or initiatives in the EU. It may also be an indication that physical factors – such as the asset's underlying technology or its location – may hinder or prevent its transition to a sustainable economy. This could include the inability to shift technology away from processes that emit greenhouse gases to the atmosphere or the inability to operate within regulatory requirements.

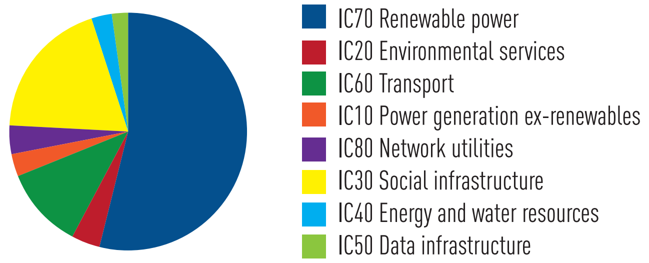
Methodology and data

Our study aims to classify infrastructure companies in Europe as sustainable or not, as per the EU taxonomy objectives of 'climate change mitigation' and 'climate change adaptation'.

The dataset of this exercise are the 5,500 European (European Economic Area and UK) companies in the EDHEC*infra* & Private Assets universe, with the breakdown by asset classes presented in figure 1. These are presented by their high-level categorisation in The Infrastructure Companies Classification Standard (TICCS) – a systematic taxonomy developed by EDHEC*infra* & Private Assets to identify infrastructure-owning companies by asset type and economic properties.

Each of these companies tracked by EDHEC*infra* & Private Assets has a primary TICCS industrial classification. The main activity of each asset subclass is identified and mapped to corresponding Nomenclature of Economic Activities (NACE) activities. NACE designates the standard integrated classification system

1. Breakdown of European infrastructure assets in the EDHEC*infra* & Private Assets dataset by TICCS superclasses



for European products and economic activities.

The EU Commission provides a mapping of the EU taxonomy activities against the NACE classification system. Thus, the NACE classification system was used as an intermediary to map the Industrial Classification pillar of TICCS to the EU taxonomy activities with the objectives of climate change mitigation and climate change adaptation. This produces a binary classification of each asset subclass as 'qualified' or 'not qualified'.

Results

From the set of 5,500 companies in the EDHEC*infra* & Private Assets universe dataset, 84% have activities that align with those defined by the EU taxonomy. This translates to a size of $1.6trn, showing that the European infrastructure asset class is highly aligned towards sustainable investment classes. Figure 2 presents the percentage of assets by asset count in each country aligned to the EU taxonomy sustainable activities.

The power sector plays a significant role in the high level of sustainability compliance in the assets considered in this study. Some of the largest super-classes of infrastructure in the TICCS classification system are compliant with taxonomy sustainability requirements. This is especially true of the power market, where renewable energy generation forms an entire investment super-class (IC70) of its own. This superclass includes 54% of all companies in this analysis. Furthermore, most of the non-renewable generation (gas and nuclear) is also classed as sustainable.

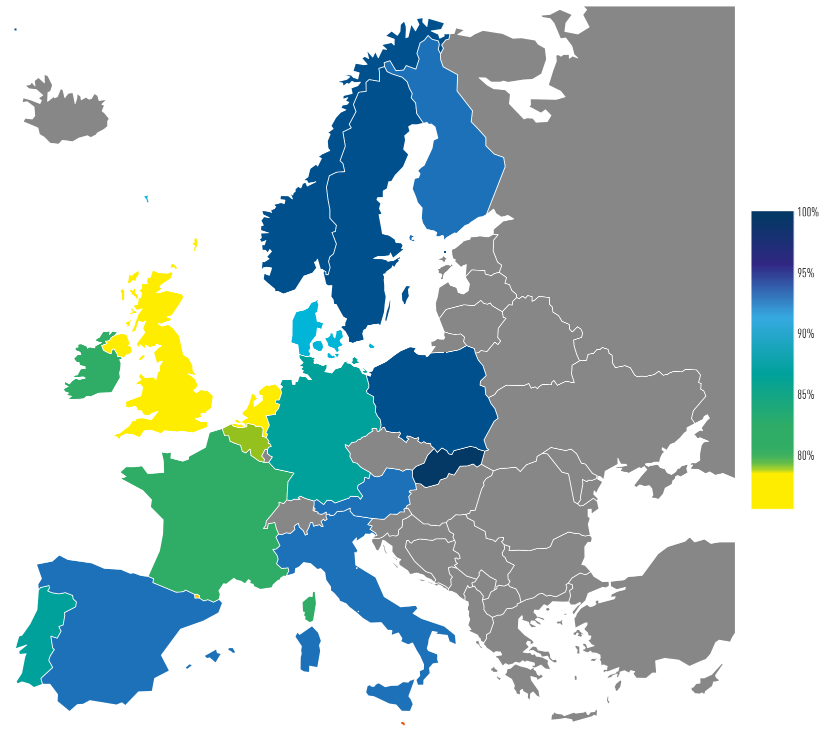
However, this high level of compliance also reflects the degree to which investment has occurred in renewables in the European market. Significant incentives have been applied at supranational level, including obligations on the proportion of renewables in power and fuel markets, and through national level policies. These include the Renewable Energy Directive at EU level. The result is that the power market consists predominantly of companies with assets that are seen as being sustainable and that this market also dominates the infrastructure assets used in this analysis.

The EU taxonomy is a list of activities that are green, but it is not a list of activities that are unsustainable. The assets that do not qualify in this exercise thus cover a range of assets that have varying characteristics – from being stranded to simply not being considered.

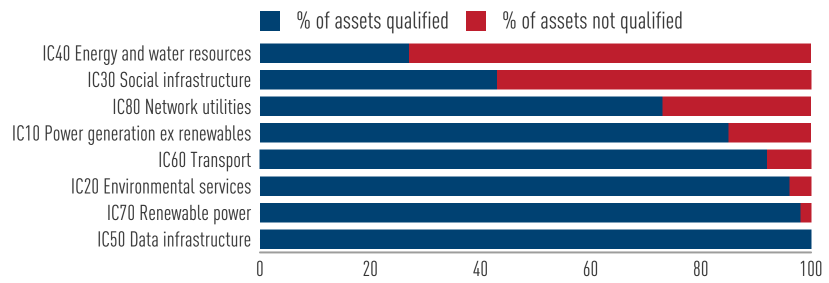
The Intergovernmental Panel on Climate Change (IPCC [2022]) describes stranded assets as those which "suffer from unanticipated or premature write-offs, downward re-valuations, or conversion to liabilities". It notes that climate policies, other policies and regulations, innovation in competing technologies and shifts in fuel prices could all lead to stranded assets. In particular, it sees coal assets being at risk of stranding before 2030, while oil and gas assets are projected to be more at risk of being stranded towards mid-century. This means that fossil fuel-intensive asset classes of coal, oil and gas are at the risk of being stranded. Among these three types of assets, the EU taxonomy qualifies natural gas as sustainable, leaving coal and oil asset classes (distribution, storage and power production) to be stranded. Following this logic, this study classifies coal and oil assets as stranded that make up about 4% by size ($10bn) of the total non-qualified assets.

A few asset classes, including social infrastructure such as buildings, do not have activities that match the EU taxonomy. While the taxonomy does not explicitly recognise the activities of these assets as green, in some cases, it is possible that they can qualify based on their characteristics or if they undertake another related activity specified in the taxonomy as sustainable – including a suitable level of renovation and improve-

2. Percentage of assets by asset count in each country aligned to EU taxonomy sustainable activities



3. Alignment of TICCS asset superclasses to the EU taxonomy of sustainable activities



ment, or by installing on-site renewables generation. As such, compliance is based on when that asset was built and what technology it uses, and it is not possible to qualify these companies as they are not explicitly identified as sustainable in the taxonomy. They are thus classified in this study as 'un-qualified'.

The EU taxonomy takes an activity-based approach to financial products, rather than an asset-based approach. This leads to some key types of infrastructure assets being excluded but which are essential to enabling other sustainable activities. For example, some asset types, such as facilities to distribute, liquify and re-gasify natural gas, are not classed as sustainable, even though their function is essential to maintaining the supply to gas-fired power stations, which are classified as green under the taxonomy. In cases such as these, these supporting asset classes were 'qualified' as sustainable ex-ante in the study.

Some social infrastructure types, particularly those consisting of land, including public parks and sports fields, are not explicitly sustainable activities following the EU taxonomy and yet have little or no adverse sustainability impact themselves. Despite the de facto sustainable operation of such assets, there appears to be no clear way of recognising this in an investment product. This is because, with the exceptions of forestry and wetland development, the sustainable use of land falls outside EU taxonomy activities. Given that these are low-carbon assets, these were also 'qualified' ex-ante as sustainable in the study.

Conclusions

This study indicates that $1.6trn of the European infrastructure asset class (European Economic Area and UK) by size is likely to qualify as sustainable under the EU Taxonomy for Sustainable Activities.

This analysis concludes that $245bn worth of infrastructure investments in Europe are not aligned with the EU taxonomy. This consists of $10bn of assets by size that have no sustainable characteristics and could be stranded in the transition to a low-carbon economy and an additional $235bn of infrastructure is not aligned with the EU taxonomy's definition of sustainability.

Lack of alignment with the two objectives of the taxonomy considered in this study – climate change mitigation and climate change adaption – are likely to strand assets during the energy transition, making carbon intensive assets in the coal and oil sector inoperable without incorporating carbon capture technology. This type of European infrastructure assets in the study is worth $10bn. The remainder of the assets that do not qualify as sustainable cannot be considered green, but also should not be considered stranded. These assets can be decarbonised with interventions, but as they are not explicitly classified as sustainable, they are considered unaligned with the taxonomy.

The EU taxonomy has been established to identify those activities that convey sustainability advantages, rather than those that are unsustainable. An asset's lack of alignment with the sustainability criteria should not be conflated with it being unsustainable, either economically or environmentally. Alignment (or the lack of it) of an asset class to the EU taxonomy as per this study does not suggest that these asset classes or companies within these asset classes are aligned by default. Rather, it means that these asset classes 'qualify' to be assessed against the 'substantial contribution' and 'do no significant harm' criteria outlined by the EU taxonomy, which are necessary to establish a company's sustainability classification.

Compared to investments that the EU taxonomy classifies as sustainable, there is little high-level indication in either the taxonomy or the SDFR as to whether exclusion of an infrastructure asset's main activities from the sustainability criteria represents a real or perceived risk to product and asset value. Nor does it reflect the ability of infrastructure assets to continue to operate as normal. This lack of clarity on sustainability may be detrimental to both product and asset value as a result of perceived risk.

InfraMetrics® by EDHEC*infra* & Private Assets provides sector-level physical and financial carbon intensity benchmarks that can be used to proxy an asset's performance against the carbon intensity sustainable contribution thresholds of the EU taxonomy.

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