Using Taxonomies to Qualify the Sustainability of Infrastructure Investments

The Infrastructure Asset Class Under the EU Green Taxonomy

April 2024

EDHEC
Infrastructure &
Private Assets
Research Institute

Contents

Authors

Nishtha Manocha is a Senior Research Engineer at EDHEC Infrastructure & Private Assets Research Institute. Her experience spans the fields of hydrology, climate adaptation and water policy. She holds a PhD at the National University of Singapore. Her research focuses on decision-making in infrastructure investments under climatic and anthropogenic uncertainties. She holds a master's degree in Hydraulic Engineering and Water Resource Management from the National University of Singapore.

Rob Arnold is the Sustainability Research Director at the EDHEC-Risk Climate Impact Institute. He is an energy and environment specialist with experience in industry, business, national governments, and international organisations. His expertise is in developing technology-led decarbonisation strategy and deriving value and business opportunities from them. He has a worked for the UK Government, developing innovative technology and approaches in the low carbon energy, climate mitigation, sustainable industry and clean transport sectors.

Executive Summary

As the popularity of sustainable investments has grown, so has the diversity of definitions of what constitutes sustainable assets. This choice of definition impacts the investment market, as a lack of consensus within the investment community over how to recognise sustainability may produce barriers to financing, development and growth.

Infrastructure assets represent an important class of real investments with distinct characteristics in terms of inflation protection and income generation, making them a compelling addition to a portfolio. However, the uncertainty on the categorisation of infrastructure assets as sustainable or not can make it difficult for investors to clearly understand the risks associated with such investments.

Sustainability taxonomies are designed to identify sustainable assets

The EU Taxonomy is one of the first global frameworks built to identify sustainable investments. 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 favourable 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 that are more exposed to transition and physical risks, as such investments carry a higher valuation (Blanc-Brude and Amenc, 2022).

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.

Using the EU Taxonomy to identify sustainable investments is challenging for infrastructure investors

The taxonomy lists "eligible" activities that can be considered sustainable. Next, for each eligible activity, the taxonomy presents a set of quantitative and qualitative criteria and thresholds, adhering to which an "eligible" activity can then be considered "aligned" to the Taxonomy.

Determining the eligibility of infrastructure companies or assets for inclusion in sustainability taxonomies is not straightforward. A company may engage in various activities across different sectors. Determining eligibility involves disaggregating a company's operations to identify the individual activities of a company and then analysing the overlap with the activities listed by the EU Taxonomy. The potential for ambiguity in defining the boundaries of specific activities and

variations in sectoral interpretations complicates this process. The complexity is further increased by the need for continuous monitoring, as taxonomies undergo updates, potentially altering eligibility criteria. Navigating these challenges is crucial for investors in integrating and tracking sustainability considerations into their portfolios.

TICCS® (or the Infrastructure Company Classification Standard) presents an exhaustive list of infrastructure asset subclasses to help investors categorise and understand the infrastructure investment landscape. This study aims to assess the sustainability of the EU investible infrastructure asset class to the activities outlined as sustainable by the EU Taxonomy. The methodology involves identifying the specific activities associated with each infrastructure asset subclass and then determining their alignment with the EU Taxonomy. In doing so, the study provides infrastructure investors with a valuable tool to determine the eligibility of any given infrastructure investment to the EU Taxonomy.

This study classifies 5,296 companies of the EDHEC*infra* European universe (European Economic Area and the UK) as eligible or not against the activities listed as sustainable by the EU Taxonomy.

Majority of the European infrastructure assets are eligible to the EU Taxonomy

Results show that from the set of 5,296 companies in EDHEC*infra*'s infra*metrics* database, 85% of the companies have activities that are eligible under the EU Taxonomy's definition of sustainability. In terms of valuation, it represents USD1.54 trillion of assets, showing that the European infrastructure predominantly can qualify as sustainable.

The EU Taxonomy identifies activities that can be considered sustainable but does not list activities that are brown. Thus, not being in the taxonomy does not mean that an activity is unsustainable by default. As such, an asset's lack of alignment with the sustainability criteria should not be conflated with the asset being considered unsustainable.

The 15% of companies that do not qualify as sustainable in this study constitute approximately USD 275.5 billion worth of infrastructure investments in Europe. Among these, USD19.6 billion of assets by size have no sustainable characteristics and would likely be stranded in the transition to a low-carbon economy. The additional USD217.1 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 categorised as unaligned to the EU taxonomy, they could potentially be decarbonised with technological interventions and in the future could meet the requirements of the EU Taxonomy. The remaining 38.8 billion of assets do not explicitly align with the EU Taxonomy's definition of sustainability but have activites that support other eligible activities.

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 centred 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 USD 81.5 billion worth of assets becoming ineligible. The share of stranded assets increases significantly, from USD19.6 billion to USD101.1 billion. This underscores the taxonomy's sensitivity to technology inclusion/exclusion and emphasises 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

It is important to note that the categorisation of an asset class as *eligible* to the EU Taxonomy, does not imply that these asset classes or the companies within them are *aligned* to the EU Taxonomy. Being eligible simply means that these assets can be further evaluated against the criteria outlined by the EU Taxonomy, specifically the "Substantial Contribution" and "Do No Significant Harm" criteria. While understanding eligibility is a crucial step in gauging sustainability, it doesn't categorise the asset as definitively sustainable. This distinction assumes that alignment is possible, but it doesn't explain how many of these assets are currently aligned or provide insights into how unaligned assets can achieve alignment.

The study concludes that the EU Taxonomy, while a crucial step, falls short of providing comprehensive insights into how infrastructure can be sustainable. This emphasises the need for a deeper understanding of alignment at the activity level, urging a more exhaustive investigation into how infrastructure companies can genuinely align and decarbonise.

The EU Taxonomy is not sufficient to improve the sustainability alignment of the infrastructure asset class

Using the taxonomy to understand the suitability of infrastructure investments comes with its set of challenges. As the taxonomy operates at an activity level, the primary challenge is identifying the activities of a company and subsequently mapping them to those of the taxonomy. Second, If the activities do not fall within those identified as eligible or fail to clear the screening criterion, they are considered not aligned. In this case, the taxonomy offers no further insights into how the given company can transition and increase its suitability to the taxonomy.

In understanding infrastructure investments, the EU Taxonomy lacks practical guidance for implementation. Additionally, there is a knowledge gap in how a company can implement strategies to eventually align with the taxonomy requirements. Bridging these gaps is crucial for enhancing the taxonomy's practical utility in understanding and achieving sustainable infrastructure investments effectively.

The key information is to know how any given asset class can sustainably undertake its activities to align with the objectives of climate change mitigation and climate change adaptation of the EU Taxonomy. For example, airports can power their operations with 100% renewable energy to reduce their emissions and climate impact. In the face of floods, airports can also build flood barriers, elevate critical components of the asset, use so-called blue-green solutions, and improve the capacity of their drainage systems.

To develop this necessary knowledge, a new joint research project at EDHEC*infra* and Private Assets and the EDHEC-Risk Climate Impact Institute (ERCII) is taking a forward-looking view on

ESG impacts and risks. This initiative aims to construct a body of knowledge on sector-specific strategies and technologies for infrastructure classes to enhance their sustainability performance and potential alignment with the EU Taxonomy. This project outlines the strategies and quantifies their technical characteristics (effectiveness), financial characteristics, and associated costs via a dedicated data collection exercise.

This project will result in sector-specific research publications and the data and information gathered will be organised into a comprehensive database called infraTech. The research allows for systematic quantification and comparison of infrastructure companies' transition and physical risks based on their adoption of specific technologies. By considering climate scenarios, socio-economic conditions, and evolving carbon regulations, this information helps to understand how a company's current technology use and future plans will alter its transition and physical risk profile. This enables the evaluation of companies' current performance and mitigation plans, facilitating the rating of their effective and potential climate risks.

Building on the taxonomy, these insights into the sustainability, effectiveness, and cost implications of strategies will provide infrastructure investors with a comprehensive understanding of how their assets can navigate climate risk and the shift to a low-carbon economy.

1. Introduction

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. However, the application of an activity-based green taxonomy for categorising infrastructure companies as sustainable or not presents its own set of challenges. The first challenge involves identifying the activities of a given company and subsequently mapping them to determine which are eligible to be screened for alignment against the taxonomy. The second challenge entails a rigorous assessment of the actual impact of these activities, measuring them to ascertain if they fall within the thresholds deemed sustainable by the taxonomy and outlining a road map to alignment if they don't

This paper addresses one of the most significant problems in this context: mapping the infrastructure asset class to the activities of the EU Taxonomy. This mapping process not only tackles a crucial hurdle but also contributes to a deeper understanding of how green taxonomies can be effectively applied to the infrastructure asset class. Additionally, the paper puts forth key recommendations aimed at improving the practical application of such green taxonomies within the infrastructure asset class, thereby bridging the gap between theoretical frameworks and real-world implementation.

1.1 Sustainability objectives drive infrastructure investments

The European Commission defines sustainable finance as the process of incorporating environmental, social, and governance (ESG) considerations into investment choices within the financial sector. In the context of the EU's policy framework, sustainable finance is seen as a means of financing economic growth while concurrently alleviating environmental pressures. Thus, sustainable finance aims to channel investments into the transition to a low-carbon, climate-resilient, resource-efficient and fair economy. This practice encourages a shift of investments towards activities that promote sustainability, enabling the attainment of climate and environmental goals outlined in the European Green Deal, with due regard for social and governance dimensions (European Commission, 2023).

Infrastructure represents an important asset class in stable, long-term, real investments. In recent years the effects of the COVID-19 pandemic, natural disasters and geopolitical events have affected the value of both private equity and publicly traded asset-based investments. These have also demonstrated that many infrastructure assets offer investment opportunities with relatively low volatility in value in comparison with other physical assets (Blanc-Brude and Amenc, 2022).

Recently, there has been an additional driver for investing in infrastructure: an increased focus at corporate and governmental levels to finance sustainable activities. Traditional infrastructure, often reliant on fossil fuels, contributes significantly to greenhouse gas emissions, specifically, in sectors like transport and energy. A report by the United Nations Environmental Program (UNEP) highlighted that the infrastructure sector is responsible for 79% of all global greenhouse gas emissions (Thacker et al., 2021). As infrastructure represents a significant portion of emissions, its decarbonisation is pivotal to achieving global climate goals. Thus investments in sustainable infrastructure are compatible with larger sustainability objectives. This is leading to infrastructure assets now developing an

additional source of value for offering returns on investment: their ability to enable a transition to a green economy (Walker, 2022).

1.2 Role of green taxonomies in identifying sustainable investments

Green taxonomies aim to identify sustainable investments by providing a standardised framework for classifying economic activities based on performance over non-financial objectives across environmental, social and governance factors.

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 bioenergy, geothermal sources, hydropower, and more.

One of the key elements of the EU Taxonomy is its role in guiding investment decisions. It is meant to offer a standardised, science-based approach to determining which economic activities align with environmental sustainability goals. This means that investors, infrastructure funds, and financial institutions should be able to use the taxonomy as a tool to evaluate the sustainability of their investments. The EU taxonomy, being a regulatory initiative, carries the weight of enforcement, enhancing its credibility and effectiveness in mitigating greenwashing.

From an investor's perspective, being excluded from the sustainability criteria of the EU Taxonomy could have consequences on the asset's overall valuation, future financing costs, operational expenditures, and exposure to regulatory obligations. Such exclusion may subject the asset to various risks, including:

- **Financial Risk:** A reduction in demand for the services provided by the asset can lead to financial risk. For example, a decline in demand for gas distribution grids may result from a shift towards electrical heating in buildings and a move away from gas-fired power generation.
- **Regulatory Risk:** Legislation and regulatory regimes may impose specific operational limitations on infrastructure assets to prevent adverse sustainability impacts. This can curtail the asset's level of operation and revenue or lead to the imposition of punitive fines for non-compliance. The consideration of carbon tax is crucial within this context, as it further impacts the financial landscape of infrastructure assets in the transition towards low-carbon economies.
- **Reputational Risk:** The perception of an asset being unsustainable and detrimental to customers' well-being can pose significant reputational risks.

These risks have the potential to strand an asset, meaning that it becomes uneconomical to operate or is rendered incapable of doing so in a sustainable manner. In the case of asset stranding, it is not solely about closing down the asset. Many infrastructure assets provide essential services to society, and closure is often not a viable option. When these assets cease to be economically viable, they are more likely to be sold at a significantly reduced value compared to their initial construction or purchase price. In instances where an asset operates at a loss, it may be sold to a public organisation capable of running the asset as a publicly funded service (e.g., roads) rather than a profit-driven business. These considerations highlight the complex interplay of financial, regulatory, and reputational risks in the context of sustainability and the potential consequences for infrastructure assets.

1.3 Objective of this study

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 categorise 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.

The objective of this study is to evaluate the overlap between the European (the EU, the European Economic Area and the United Kingdom) infrastructure asset class, as represented by the dataset of European companies tracked by EDHEC*infra*, and the EU Taxonomy's objectives concerning climate change mitigation and adaptation.

To enable this assessment, this study presents a systematic mapping of infrastructure companies classified by TICCS® to the activities of the EU Taxonomy. It analyses the challenges of using and interpreting an activity-based taxonomy to categorise infrastructure assets as sustainable (or not) and proposes key improvements that can support the applicability of such green taxonomies to the infrastructure asset class.

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 EU Taxonomy-eligible investments, positioning themselves a step ahead in meeting broader EU, Taxonomy-aligned reporting requirements. Note that alignment requires an asset level assessment of performance.

1.4 EU Taxonomy knowledge gaps and next steps

The categorisation 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 approach acknowledges that mere eligibility does not guarantee alignment and prompts the need for a deeper understanding.

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, recognising 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 EDHEC*infra* and Private Assets is building a body of knowledge on the most impactful asset-level strategies, their effectiveness, and associated costs, available to infrastructure assets to decarbonise and improve climate resilience. The strategies outlined in this study are exclusively focused on actions implementable at the asset level, deliberately excluding interventions at the national, regional, or local levels—actions within the control of asset managers and owners. The primary focus of this project is to identify strategies applicable to built assets. The selected strategies undergo careful consideration, chosen based on their fundamental level of technical viability, making them feasible for short to medium-term adoption by asset owners. This intentional approach enables a focused examination of practical, asset-level interventions within the current technological landscape. These key strategies represent the bridge from eligibility under the taxonomy to the actual alignment of the asset.

The rest of this paper is arranged as follows. First, we discuss the data and methodology used in this study. Second, we present the results, followed by the discussions and key conclusions.

2. Data and Methods

To assess the sustainability of the European infrastructure asset class, this study analyses the overlap of activities of European infrastructure companies with the activities identified as sustainable in the EU Taxonomy.

This chapter first introduces the taxonomies and datasets that enable this comparison and then presents the methods and assumptions used for this analysis.

2.1 The taxonomies

2.1.1 TICCS

TICCS® or the Infrastructure Company Classification Standard (EDHECinfra, 2022) is a class-based taxonomy that organises the constituents of the infrastructure investment universe in an objective manner. It consists of four pillars, each of which is made of non-overlapping superclasses, classes and sub-classes of pure characteristics. Real-life infrastructure companies can always be classified into a subclass of each individual pillar. Each TICCS® pillar captures a different dimension of what makes infrastructure companies unique and relatively more homogenous.

Pillar 2 presents an industrial classification that uses a very granular taxonomy of industrial activities, technologies, and asset-level characteristics that capture the potential diversity of infrastructure companies' services and products. Industrial-sector group classifications (or superclasses) represent broad areas of industrial activity but also transaction or project-development expertise. Industrial sector and subsector classifications (or classes and subclasses) represent specific industrial activities and types of physical assets and technologies.

Pillar 2 in TICCS® includes 8 industrial-group classifications (or superclasses). These are:

- IC10: Non-renewable power generation
- IC20: Environmental services (e.g., water treatment)
- IC30: Social infrastructure (e.g., health, education, defence, etc)
- IC40: Energy and resources (e.g., pipeline networks, fuels, etc)
- IC50: Data infrastructure (e.g., communications and datacentres)
- IC60: Transport (e.g. roads, rail, ports, aviation)
- IC70: Renewable power generation
- IC80: Networked utilities (e.g., gas and power grids, sewage systems)

These eight superclasses are further broken down into 35 industrial classes and 101 industrial asset subclasses.

2.1.2 The NACE classification system

NACE stands for the "Nomenclature of Economic Activities" (or *classification des activités économiques*). It is a classification system used to categorise economic activities and businesses for statistical and analytical purposes. NACE codes are primarily used in the EU, but they are similar in concept to other international industry classification systems like the North American Industry Classification System (NAICS) in the United States and the International Standard Industrial Classification (ISIC) used by the United Nations.

Economic activities are systematically classified using NACE codes in a hierarchical structure from sections to classes. There are 21 sections denoted by alphabetical letters (A to U). Divisions, identified by two-digit numeric codes, further segment activities within sections, totaling

88 divisions. Groups, with three-digit codes, categorise activities within divisions (272 groups in total). The most detailed level is the class, with 615 classes identified by four-digit numeric codes, providing highly specific descriptions of economic activities.

NACE codes are designed to be comprehensive and exhaustive within the context of European economic activities. The goal of NACE is to provide a standardised framework for classifying and describing productive economic activities. The statistics produced on the basis of NACE codes are comparable at the European level and more generally at the global level. The use of NACE codes is compulsory within the European statistics system. Most EU member states have developed their own version of the NACE codes.

2.1.3 The EU Taxonomy

As presented before, the EU Taxonomy for sustainable activities refers to a classification system established by the EU to define economic activities that are considered environmentally sustainable. It is a framework aimed at supporting the EU's objective of transitioning to a greener and more sustainable economy.

Infrastructure companies are increasingly under pressure to align their operations with sustainability criteria to access green financing options and meet regulatory requirements. Within the EU, the Taxonomy is a framework directive, designed to be referred to by other legislation and targeted towards environmental disclosure. It also forms an integral component of reporting requirements on non-financial disclosure in the finance, business, and public organisational sectors. For example, alignment to the EU taxonomy informs:

- The Non-Financial Reporting Directive (Directive 2014/95/EU) requires companies to report on the proportion of assets invested in sustainable activities in the EU Taxonomy and the proportion of capital and operational expenditure on these activities (EU Parliament, 2014).
- The Sustainable Finance Disclosures Regulation (Regulation (EU) 2019/2088) (EU Parliament, 2019), requires companies to report on the financial products in the following cases:
  - For financial products that do not specifically support sustainable activities, companies must report on how investment decisions account for sustainability risks and the likely impact of these on the returns of their products.
  - For financial products that support sustainable investments in line with Article 8 of the Regulation and whether the activities they invest in align with the EU Taxonomy.
  - For financial products that have sustainability as their core objective in line with Article 9 of the Regulation and whether the activities they invest in align with the EU Taxonomy. These are often referred to colloquially as "light green" (Article 8) and "dark green" (Article 9) funds.

The EU Taxonomy sets out six environmental objectives that economic activities must substantially contribute to in order to be considered sustainable:

- Climate change mitigation: activities that reduce greenhouse gas emissions and contribute to climate change mitigation. Examples include electricity generation from geothermal energy, bioenergy, hydropower etc.
- Climate change adaptation: activities that help society adapt to the impacts of climate change. For example, cogeneration of heat/cool and power from renewable non-fossil gaseous and liquid fuels etc.
- Sustainable use and protection of water and marine resources: activities that promote the sustainable use and protection of water resources, including marine resources.

- Transition to a circular economy: activities that support the transition to a circular economy, which involves minimising waste and promoting resource efficiency.
- Pollution prevention and control: activities that aim to prevent or reduce pollution, including air, water, and soil pollution.
- Protection and restoration of biodiversity and ecosystems: activities that promote the protection and restoration of biodiversity and ecosystems.

As of today, the EU taxonomy presents a set of activities that can be considered as *eligible* for the first two objectives of the taxonomy i.e. climate change mitigation and climate change Adaptation. 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 scope of the Taxonomy to begin with. To be considered *aligned*, an economic activity must meet specific technical screening criteria, including thresholds for greenhouse gas emissions, resource use, and other relevant factors. Taxonomy alignment is the positive assessment that an eligible activity meets the applicable Taxonomy requirements to substantially contribute to at least one of the Taxonomy's six objectives; "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.

In addition to the identified sustainable activities, the EU Taxonomy includes two additional types of activity categories. These are enabling activities and transitional activities. These are added to the taxonomy to accommodate activities that might not otherwise meet the criteria for sustainability but still contribute to the overarching goal of advancing environmental sustainability.

Enabling activities as the name suggests, supports other activities to make substantial contributions to one or more of the Taxonomy's six environmental objectives. These enabling activities are expected to deliver a positive environmental impact throughout their entire lifecycle. Examples of such activities are storage of electricity, storage of hydrogen and thermal energy etc. Nevertheless, it is important to note that enabling activities should not result in a situation where assets become 'locked in,' hindering the pursuit of long-term environmental objectives. For instance, a company heavily investing in large-scale battery storage infrastructure using current technologies with environmentally harmful materials or unsustainable manufacturing processes may face challenges if more sustainable alternatives emerge in the future. This underscores the importance of carefully assessing enabling activities to avoid situations where assets become entrenched in outdated or environmentally unfriendly practices, impeding progress towards long-term environmental sustainability goals.

Transition activities, on the other hand, are specifically intended to support climate change mitigation efforts and align with the objective of adhering to commitments outlined in the Paris Agreement. For a transition activity to qualify, it must satisfy a set of stringent criteria:

- There are no technologically or economically feasible low-carbon alternatives;
- Greenhouse gas emission levels correspond to the best performance in the sector or industry; and
- The activity does not lead to carbon lock-in or hamper the development and deployment of low-carbon alternatives.

As per the taxonomy, activities related to producing energy from fossil gaseous fuels (natural gas) and electricity generation from existing nuclear facilities are classified as transition activities.

2.2 The dataset

2.2.1 EDHEC*infra* European universe

EDHEC*infra* maintains a comprehensive database of unlisted infrastructure assets. Also known as the *Unlisted Infrastructure Universe*, the tracked assets are designed to represent the fair value- and risk-adjusted performance of the unlisted infrastructure asset class in general. It includes 9,000 unique infrastructure companies in the 25 most active national markets for infrastructure investors to define an investible universe of private infrastructure companies. These companies have a minimum of USD 1 million in total asset book value and are privately owned. In addition to this, each company has a TICCS® classification for each of the four pillars described previously, the total asset size, enterprise value and equity value.

For this exercise, we focus on 5,296 European companies of the EDHEC*infra* universe with a total asset value of USD 1.82 trillion. The dataset of companies used in this study has the distribution by industrial superclass as shown in Figure 1 and by country in Figure 2.

In terms of number of assets, renewable power assets (IC70) dominate the tracked European assets, constituting 55% of the dataset, followed by social infrastructure (IC30) at 19%, and transport (IC60) at 10%. Conversely, when considering the value of assets, network utilities (IC80) and renewable energy (IC70) account for 27% and 26% of the dataset respectively, followed by transport (IC60) at 21%. Notably, social infrastructure (IC30), and, energy and water resources (IC40), contribute 8% and 6%, respectively, to the total value. The remaining superclasses each represent 5% or less of the dataset by number and value, underscoring the nuanced distribution of assets within the European infrastructure sector. The power sector (IC10 and IC70) in total makes up 57% of this database by numbers and 29% by value

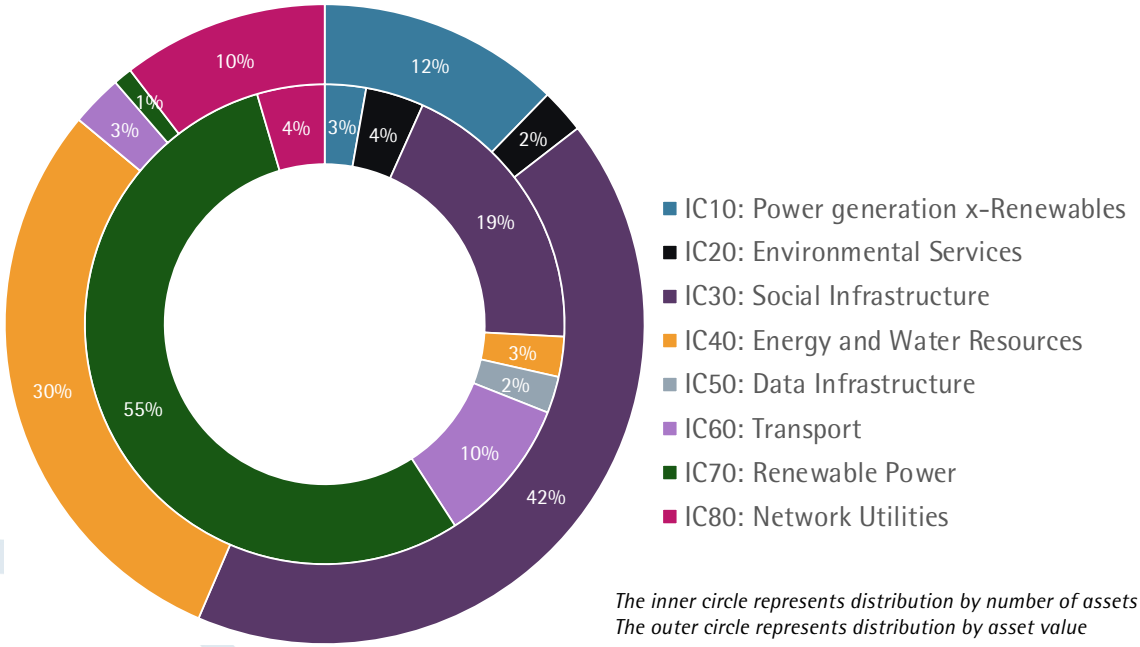
In the context of the geographic distribution of assets, the UK exhibits the highest representation in this dataset, with 1,868 companies. Spain follows with 948 companies, while France, Italy, and Germany also feature prominently with 638, 519, and 406 companies, respectively. Collectively, other countries contribute 917 assets. In terms of value, infrastructure assets of the UK in the dataset constitute 38% of the total assets in the universe, amounting to a substantial value of USD690.8 billion.

2.3 Methodology

The assessment of the sustainability of the European infrastructure asset class, as represented by the EDHEC*infra* European Universe, is conducted through a systematic methodology, consisting of the following key steps:

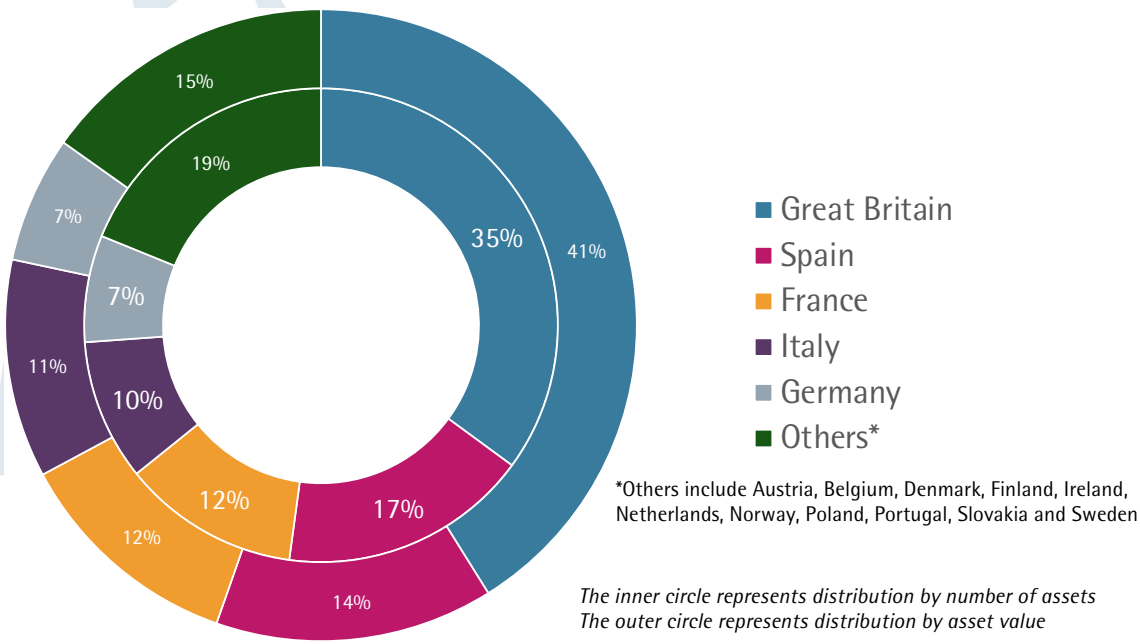
1. **Identification of main activities of each TICCS® subclass:** Contrary to TICCS®, which identifies the main sector that a company operates in, the EU Taxonomy lists activities that are sustainable. Thus in order to understand if an asset subclass, vis-a-vis the company within that subclass, is sustainable or not, we first identify the primary activities associated with a given TICCS® industrial subclass.
2. **Mapping of TICCS® to NACE**: Subsequently, the primary activities of individual subclasses are mapped to activities of the NACE classification system. As mentioned above, the NACE classification system serves as the primary identifier for all economic activities within the EU. Notably, the EU Taxonomy itself relies on the NACE classification as its foundational basis.
3. **Mapping TICCS® to the EU Taxonomy:** The final step entails the mapping of TICCS® activities to those of the EU Taxonomy, using NACE activities as a bridge. This mapping process enables the determination of whether a given asset subclass is associated with activities deemed sustainable according to the criteria outlined in the EU Taxonomy.

Figure 1: Distribution of the EDHECinfra European Universe by TICCS® superclasses



The inner circle represents distribution by number of assets
The outer circle represents distribution by asset value

Figure 2: Distribution of the EDHECinfra European Universe by country



*Others include Austria, Belgium, Denmark, Finland, Ireland, Netherlands, Norway, Poland, Portugal, Slovakia and Sweden

The inner circle represents distribution by number of assets
The outer circle represents distribution by asset value

These steps are explained in detail below.

2.3.1 Identification and mapping of TICCS® to NACE activities

Any infrastructure asset subclass can be associated with multiple activities. For example, while an airport's main activity is "Air Transport," which falls under the NACE code "51.10 - Passenger air transport" and "51.21-Freight air transport" However, an airport engages in a variety of activities beyond its main function such as:

- Passenger services (NACE Code - 52.23 - Service activities incidental to air transportation)
- Aircraft services (NACE Code 33.16- Repair and maintenance of aircraft and spacecraft)
- Retail and commercial operations, cargo and freight services (NACE Code- 52.24-Cargo handling),
- Air traffic control and navigation services (NACE Code - 52.23 - Service activities incidental to air transportation)

- Facilities management (NACE code 33.20 Installation of industrial machinery and equipment)
- Construction services (NACE code 42.99-Construction of other civil engineering projects, 41.20 Construction of residential and non-residential buildings).

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 the sustainability assessment is centred around the primary function of the asset. Examining a (small) sub-activity does not necessarily reflect the overall sustainability of the asset. In contrast, emphasising the main activity provides a more accurate representation of the asset's predominant function and its alignment with sustainability considerations. This approach thus ensures that the evaluation captures the essence of an asset's sustainability, avoiding potential distortions introduced by sub-activities.

2.3.2 Mapping TICCS® to the EU Taxonomy

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

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.

If the main activity of a TICCS® asset subclass is mapped to a corresponding EU Taxonomy Activity it is considered as *eligible* under the EU taxonomy objectives of climate change mitigation and climate change adaptation. This includes all activities of the EU Taxonomy including the transition and enabling activities. Note that once an asset is identified as *eligible*, it still needs to meet the technical screening criterion and Do No Significant Harm (DNSH) criterion to be considered as *aligned* to the EU Taxonomy.

Discretionary Categorisation by EDHECinfra

The EU Taxonomy is a list of activities that are sustainable, but it is not a list of activities that are unsustainable 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 subclasses) are unsustainable. The asset classes that are not eligible for the EU Taxonomy thus cover a range of assets from those that are obviously unsustainable such as fossil fuel power plants, to those that are inherently green (such as parks) and don't need to be considered for sustainability alignment. In this situation, a coal power plant and a public park are both given the same *not eligible* status by the EU Taxonomy. In addition to this, there are asset subclasses whose sustainability eligibility is ambiguous and cannot be understood categorically i.e. they could be sustainable or not based on the technology and strategies employed by individual assets within this subclass such as the social infrastructure assets using renewable power and implementation of energy saving measures.

To overcome these challenges and get a clearer picture of the eligibility of the infrastructure asset class with the EU taxonomy, an additional step of discretionary categorisation was carried out by EDHEC*infra* in this study. To further differentiate between those asset classes that were identified

as "not eligible" according to the EU Taxonomy, we mapped those infrastructure classes to four additional discretionary categories:

The following are the categories of eligibility to which each TICCS® asset subclass was mapped:

- **Low-Carbon Assets (Eligible):** These are assets that have little or no adverse sustainability impact themselves, but the main activities of which are not explicitly sustainable following the EU taxonomy. Despite the de facto sustainable operation of such assets, there appears 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. These assets were categorised as *eligible* ex-ante. Examples of this include public parks and gardens.
- **Supporting Assets (Not eligible):** These assets do not have a primary activity overlapping with those identified as sustainable under the EU Taxonomy. However, their significance lies in the critical role they play in supporting and facilitating activities classified as sustainable within the Taxonomy's framework. An example includes infrastructure assets for the distribution, liquefaction, and natural gas regasification. While these asset subclasses may not fall clearly into the sustainable category, their function is instrumental in supporting the infrastructure necessary for maintaining the supply to gas-fired power stations—an activity that qualifies as sustainable according to the EU Taxonomy. Investors are likely to be drawn to such infrastructure as they are of strategic importance given their key role in ensuring the stability and continuity of eligible sustainable activities. It is because these assets enhance the resilience and predictability of sustainable activities, which, in turn, can have a positive impact on environmental and social objectives.
- **Potentially Stranded Assets (Not eligible):** The Intergovernmental Panel on Climate Change (IPCC) describes assets which "suffer from unanticipated or premature write-offs, downward revaluations or conversion to liabilities" as being "stranded assets" (IPCC WG III, 2014). The IPCC emphasises that various factors, including climate policies, other regulations, technological innovations in competing sectors, and fluctuations in fuel prices, can contribute to assets becoming stranded. Specifically, it is anticipated that coal assets may face stranding risks before 2030, while oil and gas assets are expected to be at risk of stranding around the mid-point of this century. Consequently, in this study, coal and oil assets are considered to be potentially at risk of stranding and are referred to as "ineligible stranded assets." As the taxonomy qualifies gas as a sustainable "transition" activity, it is considered eligible for this study.
- **Ambiguous Assets (Not eligible) :** Assets falling within this category lack a primary activity that directly aligns with the list of Taxonomy activities. However, they hold the potential to be considered sustainable based on the policies, technologies, and strategies they adopt. For instance, social infrastructure assets can engage in sustainability-promoting activities like renovating existing structures or implementing renewable energy generation systems. While these ad-hoc activities are unequivocally sustainable, they do not represent the principal activity within this asset class. As a result, asset subclasses of this nature are labelled as "not eligible ambiguous assets" because it is not feasible to definitively assert whether an asset in this subclass qualifies as sustainable under the Taxonomy. The ambiguity arises from the coexistence of core asset functions and the additional sustainable activities they may undertake, making it challenging to make a categorical determination of their Taxonomy eligibility.

The final mapping that categorises each TICCS® asset subclass in accordance with the taxonomy is presented in the next chapter.

3. Results and Discussions

3.1 The eligibility of TICCS® classes to the EU Taxonomy

Tables 1 and 2 present the eligibility of TICCS® asset sub-classes to the EU Taxonomy as per the categories described in the previous chapter.

Looking at the eligibility of the European assets at the superclass level (see Figure 3), we find that:

- **IC10: Non-renewable power generation:** Not all asset subclasses in this superclass of non-renewable power are ineligible. Nuclear, gas and Combined heat and power assets are eligible as per the EU Taxonomy while coal and other fossil fuel-fuelled power generation assets are not. In the dataset used in this study, this translates to 79% of the IC10 assets by value, being eligible to the taxonomy. Of the 21% of assets that are not eligible, all of them are expected to be stranded in the transition to a low-carbon economy.
- **IC20: Environmental services:** Activities related to carbon capture, waste treatment, water treatment, and wastewater treatment fall under the purview of the EU Taxonomy, constituting the majority of the IC20 superclass. This makes 96% of the IC20 dataset, eligible for EU Taxonomy compliance. The remaining 4% comprises assets from subclasses like waste incineration, desalination, and water supply dams. Notably, these subclasses are categorised as ambiguous, signifying that while they do not explicitly meet the criteria of the taxonomy, these assets have the potential to undertake additional sustainable activities, qualifying them under the taxonomy. For instance, a desalination plant utilising renewable energy for its processes could potentially be eligible. Hence, making a definitive determination of their EU Taxonomy eligibility proves challenging without more granular asset-level information.
- **IC30: Social infrastructure:** The majority of assets within the social infrastructure superclass are not eligible for EU Taxonomy compliance; instead, they fall under the ambiguous category. However, specific asset classes within this category, such as educational institutions, arts, museums, libraries, and convention centres, are deemed eligible. In the dataset under examination for this study, only 30% of companies by value, within the IC30 category are eligible for the EU Taxonomy. Notably, IC30 emerges as the asset class with the highest number of assets that do not align with the EU Taxonomy criteria.
- **IC40: Energy and water resources**: This superclass encompasses assets involved in transporting, processing, and storing natural resources such as gas, oil, and water. The eligible asset classes within this category include gas pipelines, LNG ships, and biofuel processing facilities. However, a majority of subclasses within this superclass are deemed ineligible for the EU Taxonomy. While oil pipelines and refineries being stranded, other infrastructure assets like water and wastewater pipelines, LNG liquefaction and regasification plants, and gas storing facilities are also ineligible. Notably, these infrastructure assets support other green activities qualified under the taxonomy. Based on this classification, our data indicates that 51% of assets by value within IC40 are eligible for the EU Taxonomy.
- **IC50: Data infrastructure:** This superclass includes companies involved in the provision of telecommunication and data infrastructure. All companies in this superclass are eligible to the EU Taxonomy.
- **IC60: Transport:** This superclass comprises companies engaged in providing trans-

Table 1: Eligibility of TICCS® Subclasses to the EU Taxonomy objectives of Climate Change Mitigation or Climate Change Adaptation

TICCS® SubclassCode	Asset Subclass Name	Eligibility Status	Additional Categorisation
IC101010	Nuclear Power Generation	Eligible	
IC101020	Gas-Fired Power Generation	Eligible	
IC101030	Coal-Fired Power Generation	Not Eligible	Stranded
IC101040	Combined Heat and Power Generation	Eligible	
IC101050	Other Fossil-Fuel-Fired Power Generation	Not Eligible	Stranded
IC102010	Power and Water Production	Not Eligible	Ambiguous
IC201010	Non-Hazardous Waste Treatment	Eligible	
IC201020	Hazardous Waste Treatment	Eligible	
IC201030	Waste-to-Power Generation	Eligible	
IC201040	Waste incineration	Not Eligible	Ambiguous
IC201050	Gaseous Waste Treatment	Not Eligible	Ambiguous
IC202010	Potable Water Treatment	Eligible	
IC202020	Industrial Water Treatment	Eligible	
IC202030	Sea Water Desalination	Not Eligible	Ambiguous
IC202040	Water Supply Dams	Not Eligible	Ambiguous
IC203010	Residential Wastewater Treatment and Reuse	Eligible	
IC203020	Industrial Wastewater Treatment and Reuse	Eligible	
IC204010	Flood Control	Not Eligible	Low Carbon
IC204040	Carbon Capture	Eligible	
IC301010	Strategic Transport and Refueling	Not Eligible	Ambiguous
IC301020	Training Facilities	Not Eligible	Ambiguous
IC301030	Barracks and Accommodation	Not Eligible	Ambiguous
IC302010	Schools (Classes and Sports Facilities)	Eligible	
IC302020	Universities (Classes, Labs, Administration Buildings)	Eligible	
IC302030	Student Accommodation	Eligible	
IC303010	Police Stations and Facilities	Not Eligible	Ambiguous
IC303020	Courts of Justice	Not Eligible	Ambiguous
IC303030	Prisons	Not Eligible	Ambiguous
IC303040	Street Lighting	Not Eligible	Ambiguous
IC303050	Social Accommodation	Not Eligible	Ambiguous
IC303060	Government Buildings and Office Accommodation	Not Eligible	Ambiguous
IC304010	Hospitals	Not Eligible	Ambiguous
IC304020	Clinics	Not Eligible	Ambiguous
IC304030	Residential and Assisted Living	Not Eligible	Ambiguous
IC304040	Crematorium	Not Eligible	Ambiguous
IC305010	Stadiums and Sports Centers	Not Eligible	Ambiguous
IC305020	Public Parks and Gardens	Not Eligible	Low Carbon
IC305030	Convention and Exhibition Centers	Eligible	
IC305040	Arts, Libraries, and Museums	Eligible	
IC401010	Gas Pipeline	Eligible	
IC401020	Oil Pipeline	Not Eligible	Stranded
IC401030	Water Pipeline	Not Eligible	Supporting
IC401040	Wastewater Pipeline	Not Eligible	Supporting
IC401050	LNG Ships	Eligible	
IC402010	Liquefied Natural Gas - Liquefaction	Not Eligible	Supporting
IC402020	Liquefied Natural Gas - Regasification	Not Eligible	Supporting
IC402030	Crude Oil Refinery	Not Eligible	Stranded
IC402040	Bioethanol Fuel	Eligible	
IC403010	Gas Storage	Not Eligible	Supporting
IC403020	Liquid Storage	Not Eligible	Ambiguous
IC403030	Other Storage	Not Eligible	Ambiguous
IC403040	Floating Storage Units - FSU	Not Eligible	Supporting
IC501010	Cell Towers	Eligible	
IC501020	Long-Distance Cables	Eligible	
IC501030	Communication Satellites	Eligible	
IC502010	Data Centers	Eligible	
IC601010	Airport	Eligible	
IC602010	Car Park	Not Eligible	Ambiguous
IC603010	Tool Port	Not Eligible	Ambiguous
IC603020	Bulk Goods Port	Eligible	
IC603030	Container Port	Eligible	
IC603040	Other Port	Eligible	

Table 2: Eligibility of TICCS® Subclasses to the EU Taxonomy objectives of Climate Change Mitigation or Climate Change Adaptation

TICCS® SubclassCode	Asset Subclass Name	Eligibility Status	Additional Categorisation
IC604010	Heavy Rail Lines	Eligible	
IC604020	High-Speed Rail Lines	Eligible	
IC604030	Freight Rail Rolling Stock	Eligible	
IC604040	Passenger Rail Rolling Stock	Eligible	
IC605010	Motorways	Eligible	
IC605020	Motorway Network	Eligible	
IC605030	Dual-Carriageway roads	Eligible	
IC605040	Stand-Alone Tunnels	Not Eligible	Ambiguous
IC605050	Stand-Alone Bridges	Not Eligible	Ambiguous
IC606010	Urban Light-Rail	Eligible	
IC606020	Underground Mass Transit	Eligible	
IC606030	Overground Mass Transit	Eligible	
IC606040	Bus Transportation	Eligible	
IC701010	On-Shore Wind Power Generation	Eligible	
IC701020	Off-Shore Wind Power Generation	Eligible	
IC702010	Photovoltaic Power Generation	Eligible	
IC702020	Thermal Solar Power	Eligible	
IC703010	Hydroelectric Dam Power Generation	Eligible	
IC703020	Hydroelectric Run-of-River Power	Eligible	
IC703030	Pumped Hydroelectric Storage	Eligible	
IC704010	Biomass Power Generation	Eligible	
IC704020	Geothermal Power Generation	Eligible	
IC704030	Wave Power Generation	Eligible	
IC705010	Battery Storage	Eligible	
IC705020	Off-Shore Transmission (OFTO)	Not Eligible	Ambiguous
IC705030	Thermal Storage	Eligible	
IC706010	Hydrogen-fired Power Generation	Eligible	
IC706020	Hydrogen Fuel Cells	Eligible	
IC706030	Hydrogen Storage	Eligible	
IC801010	Electricity Distribution Network	Eligible	
IC802010	Electricity Transmission Network	Eligible	
IC803010	District Cooling/Heating Network	Eligible	
IC804010	Water and Sewerage Network	Eligible	
IC805010	Gas Distribution Network	Eligible	
IC806010	Data Distribution Network	Not Eligible	Ambiguous
IC807010	Smart Metering Network	Eligible	

Figure 3: Eligibility of the EDHECinfra European assets to the EU Taxonomy, Superclass summary by asset value

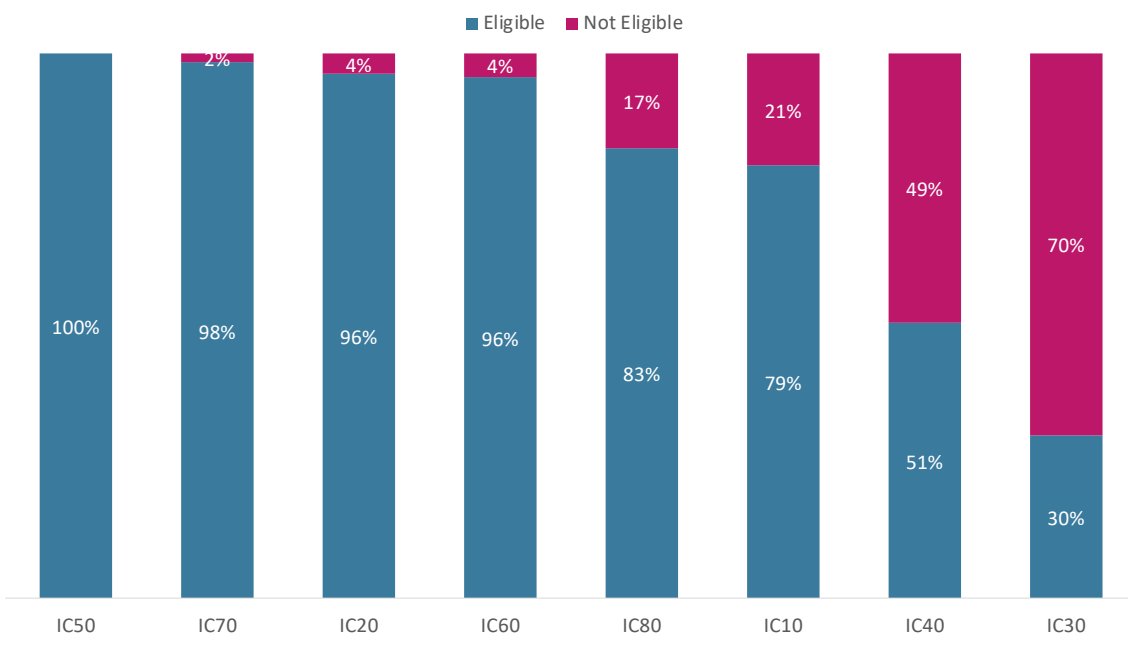
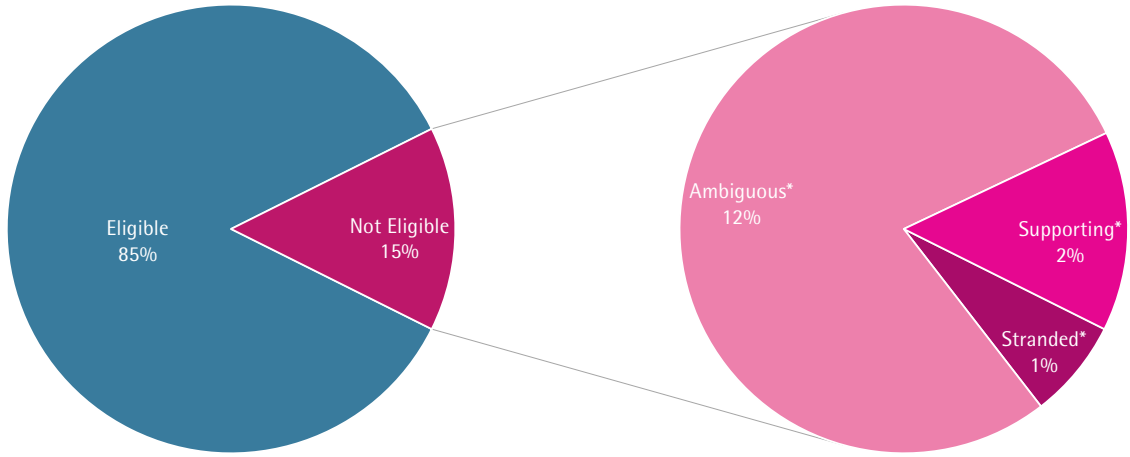


Figure 4: Eligibility of the EDHECinfra European Assets to the EU Taxonomy, by asset value. Note that the eligible asset include both those initially designated as eligible and those that have been re-categorised as low carbon assets.



portation infrastructure services. The majority of transport asset subclasses are eligible for the EU Taxonomy, with a few exceptions such as car parks, tunnels, and bridges, which fall under the category of ambiguous assets. In the dataset examined for this study, 96% of transport companies by value are eligible for EU Taxonomy compliance.

- **IC70: Renewable power generation:** With the exception of off-shore transmission which is ambiguous and not eligible, all other subclasses of renewable power generation are eligible to the EU Taxonomy. This high level of compliance is reflected in the dataset which shows that 98% of European companies by value, in the IC70 superclass are eligible to the EU Taxonomy.
- **IC80: Networked utilities:** Companies within this superclass are engaged in the distribution and transmission of electricity, data, heat, cooling, water, and gas. The data distribution companies within this superclass are considered ambiguous, while all other subclasses are eligible for the EU Taxonomy. Consequently, 83% of the European IC80 superclass by value, is deemed eligible based on the data.

3.2 How sustainable is the European infrastructure asset class as per the EU Taxonomy?

The infrastructure assets examined in this study collectively represent a substantial asset base, exceeding USD1.82 trillion. Of this total, approximately USD1.54 trillion worth of assets or 85% of assets by value, align with the EU Taxonomy's definition of sustainability (Refer to Figure 5). The low carbon assets, with a value of about USD 3.0 million, amount to less than 0.5% of the total eligible assets. This high percentage underscores a significant level of alignment between the activities of these companies and the sustainability criteria outlined by the EU Taxonomy, emphasising the growing importance of sustainable practices in the Europe.

However, a significant 15% of assets, equivalent to approximately USD275.5 billion in value, fall outside the parameters set by the EU Taxonomy, prompting important considerations about the long-term value retention of these assets. The breakdown of these assets is as follows and is presented in Figure 4:

- **Potentially Stranded assets:** Approximately USD19.6 billion falls under this category, encompassing coal and oil infrastructure assets, constituting to only about 1% of the total infrastructure assets tracked in this study. Given the predominant reliance on renewable

energy for primary energy production in the EU and fossil fuels contributing only about 18% to total energy production (Eurostat, 2023), it appears logical that there aren't a substantial number of private infrastructure assets in this category in the EU.

- **Supporting assets:** Approximately 2% of assets, valued at USD38.8 billion, fall into the category of supporting other eligible sustainable assets, such as LNG liquefaction and regasification facilities. Recognising that reliable supporting infrastructure enhances the resilience and predictability of these activities, these asset types are anticipated to be valued beyond just the environmental constraints of the taxonomy.
- **Ambiguous assets:** The largest segment, valued at about USD217.1 billion, consists of assets primarily in the social infrastructure sector. While not explicitly eligible as per the taxonomy, these assets cannot be overlooked, as they may become eligible if operated in a sustainable manner. These make up 12% of the European assets assessed. Assets falling within this category lack a primary activity that directly aligns with the list of Taxonomy activities. However, they hold the potential to be considered sustainable based on the policies, technologies, and strategies they adopt. For instance, social infrastructure assets can engage in sustainability-promoting activities like renovating existing structures or implementing renewable energy generation systems. While these ad-hoc activities are unequivocally sustainable, they do not represent the principal activity within this asset class, but have the ability to significantly reduce the carbon footprint of the asset making it sustainable. As a result, asset subclasses of this nature are labelled as ambiguous because it is not feasible to definitively assert whether an asset in this subclass qualifies as sustainable under the Taxonomy. As such these assets should be given special attention when undertaking taxonomy alignment exercises.

As depicted in Figure 6, the level of compliance varies across countries, ranging from 94% in Italy to about 65% in France. Figure 7 presents a breakdown of the type of not eligible asset per country.

Taking a granular approach, we find that Germany, in particular, exhibits the highest share of stranded assets, with 3% of German assets valued at USD4.3 billion at the risk of stranding. On the other hand, the UK has the highest value of assets at risk, totalling USD5.6 billion. Interestingly, across countries, the predominant category of ineligible assets comprises ambiguous assets, primarily from IC30, social infrastructure.

3.2.1 Role of Energy Infrastructure in making the EU infrastructure asset class sustainable

The high level of compliance of the European infrastructure asset class with the EU Taxonomy reflects the degree to which investment has occurred in the renewables sector in the European market. Significant incentives have been applied at a 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 (EU Parliament, 2018) which is a legislative framework designed to advance the utilisation of renewable energy sources and elevate their proportion within the EU's overall energy composition. Noteworthy within this legislative landscape is the Renewable Energy Directive (RED), a key regulatory instrument that establishes both EU-wide and national targets for the incorporation of renewable energy. The directive encompasses sustainability criteria for bioenergy and outlines measures to encourage renewable energy adoption across various sectors, including electricity, heating and cooling, and transportation.

The EU Taxonomy Regulation is closely linked to the RED as both are key components of the European Union's broader sustainability and

Figure 5: Value of the EU Taxonomy eligibility of the EDHECinfra European universe

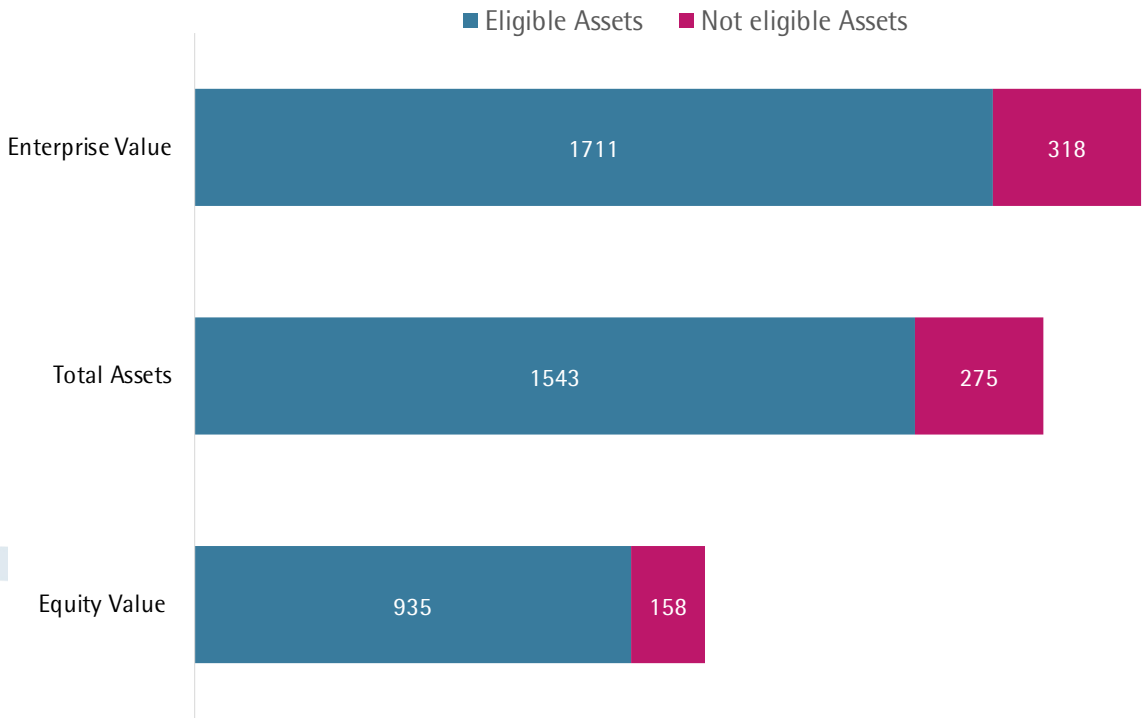


Figure 6: Country level eligibility of European Infrastructure Assets to EU Taxonomy, by value. The total number of assets in each country is presented in parenthesis.

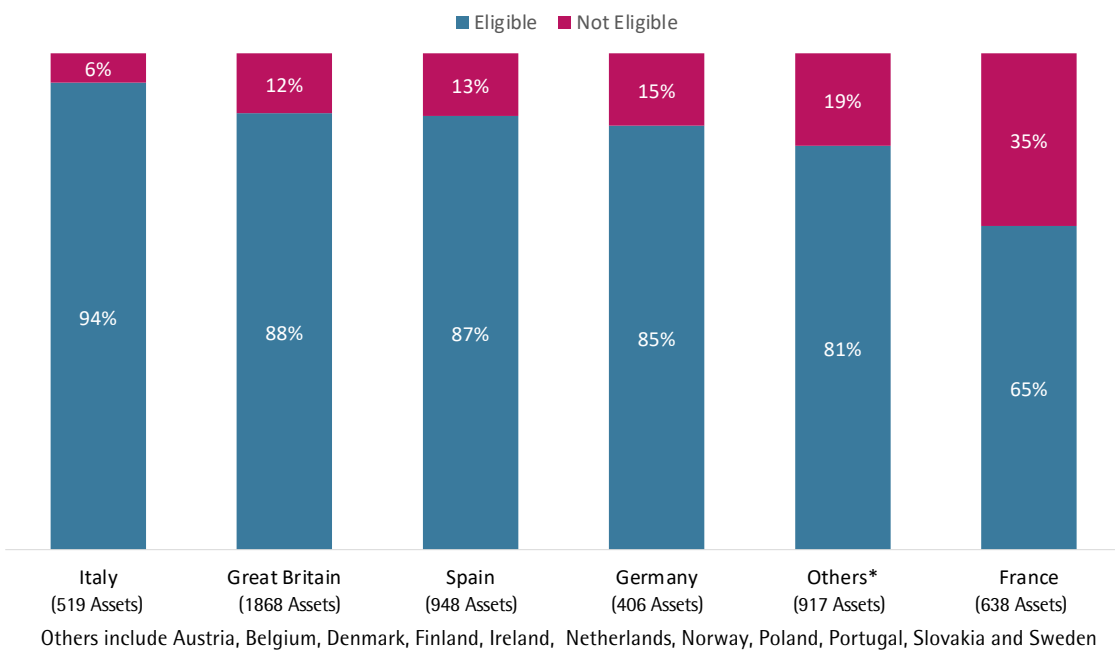
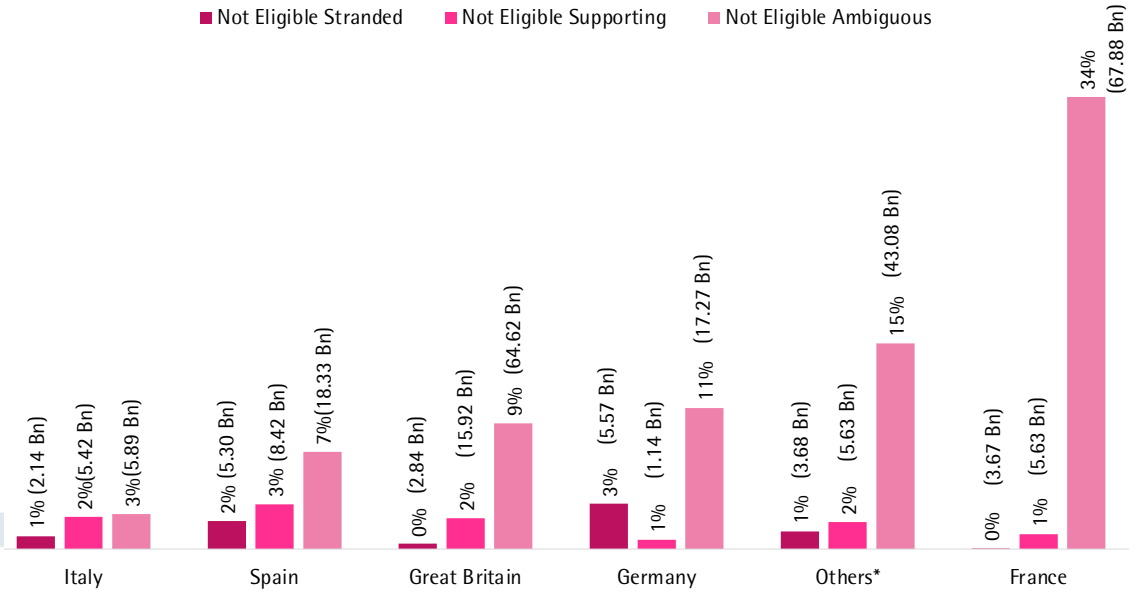


Figure 7: Country-level distribution of assets not eligible to the EU Taxonomy. The percentages indicate the share by value of a given category in a country. The gross value of assets in each country per category is presented in parenthesis.



*Others include Austria, Belgium, Denmark, Finland, Ireland, Netherlands, Norway, Poland, Portugal, Slovakia and Sweden

climate action framework. While the Renewable Energy Directive primarily focuses on promoting the use of renewable energy and establishing renewable energy targets, the EU Taxonomy Regulation provides a classification system for sustainable economic activities, including those related to renewable energy. In essence, the EU Taxonomy and the Renewable Energy Directive work in tandem to guide and promote sustainable practices within the European Union, with the Taxonomy providing a broader framework for assessing the environmental sustainability of various economic activities, including those related to renewable energy, as outlined in the Renewable Energy Directive.

During the formulation of the EU Taxonomy, there was considerable debate of the inclusion of nuclear and gas activities. This debate reflected the challenge of harmonising sustainability criteria across diverse energy mixes within EU member states. Key concerns revolved around whether nuclear and gas could be considered sustainable, given issues like greenhouse gas emissions, prolonged lead times for nuclear projects, and the management of radioactive waste. Critics voiced apprehensions that their inclusion might compromise the taxonomy's credibility and alignment with climate objectives. Despite objections from environmental groups, investors, and EU Parliament members, gas and nuclear were ultimately added to the taxonomy as transition activities, recognising the absence of readily available low-carbon alternatives (EU Parliament News, 2022).

To understand the consequences of an alternative classification, particularly with respect to the eligibility of gas and nuclear assets within the European infrastructure asset class, and to assess how excluding these technologies would reshape the overall categorisation of assets under the EU Taxonomy, we conducted a reassessment of European asset eligibility to the EU Taxonomy. In this reassessment, gas and nuclear assets were classified as ineligible.

Excluding gas and nuclear assets, the proportion of eligible assets by value, declines from 85% to 80%, translating to about USD81.5 billion worth of assets becoming ineligible. Notably, the share of stranded assets increases from USD19.6 billion to USD101.1 billion, emphasising the potential for investors holding sustainable assets to be burdened with non-compliant assets if the taxonomy is revised. In the IC10 super-

class, eligibility plummets from 79% to 23%, indicating a significant change in the taxonomy's influence on non-renewable power generation assets. Country-level effects vary, with Italy, UK and France experiencing a substantial 96%, 75% and 52% reduction in eligibility respectively, while Germany and Spain witnessing a 22% and 23% decrease respectively.

This outcome highlights the taxonomy's sensitivity to the inclusion or exclusion of specific technologies, emphasising the intricate relationship between regulatory decisions, investment landscapes, and the broader goal of sustainable infrastructure practices. It underscores the crucial role of regulators in shaping the sustainability narrative and the challenges associated with adapting regulations to align with the changing energy landscape.

4. Conclusions

This paper examines the role that green taxonomies play in defining and identifying sustainable infrastructure investments. The urgency of climate change and the global effort to transition to low-carbon economies has seen the development of multiple frameworks, taxonomies, and standards. This report analysed on the challenges of using and interpreting an activity-based taxonomy to categorise infrastructure assets as sustainable (or not) and proposes key improvements that can support the applicability of such taxonomies to the infrastructure asset class. The primary objective of this paper is to analyse the alignment of the European infrastructure asset class represented by the EDHEC*infra* European universe to the EU Taxonomy's climate change mitigation and adaptation objectives.

Classification as a sustainable investment carries multiple advantages for infrastructure assets. Green investments often gain access to public sector financial incentives, including cash grants, soft loans, and tax benefits, as well as private sector loans. Furthermore, being classified as sustainable may signify a lower technology risk during the transition towards a country's long-term climate policy objectives. This acceleration in financial accessibility for sustainable asset classes is expected to stimulate their growth and significantly contribute to the broader shift towards a sustainable economy.

The EU's Taxonomy Regulation is a significant step toward this goal, aimed at classifying and promoting sustainable economic activities. However, applying the EU Taxonomy to infrastructure assets is complex. Investors and asset managers are increasingly in need of clear and practical guidance for understanding and implementing the EU Taxonomy criteria within the context of infrastructure assets.

The TICCS® to EU Taxonomy mapping presented in this paper serves as a valuable tool for infrastructure investors, offering them a systematic way to approach and understand the sustainability and associated investment risks of their infrastructure portfolio. Identifying the eligibility of investments to the EU Taxonomy also serves as an initial step in meeting broader EU reporting requirements. Thus, the mapping presented in this study also provides investors with a foundational resource to navigate the EU reporting landscape.

The implications of not being classified as sustainable according to the EU Taxonomy extend beyond a simple binary classification of eligible or not eligible. The absence of sustainability classification doesn't inherently mean these assets are unsustainable. Many of them may still attract investments. However, it introduces potential financial risks from decreased demand, regulatory constraints, and reputational issues. These risks can lead to scenarios where assets may be stranded, experience devaluation, or operate at a loss.

To better understand the implications of being classified as unsustainable, the classification presented in this study, while confined to the boundary of the EU Taxonomy, takes one step further in identifying why a given TICCS® asset subclass is not eligible for the taxonomy. Assets that are not qualified as sustainable are further classified into categories of: supporting assets, potentially stranded assets, and ambiguous assets.

The results of this study show that, from the 5,296 companies in the dataset, USD1.54 trillion

of total asset value, translating to about 85% of companies, had activities that align with those defined as sustainable by the EU Taxonomy.This indicates that the majority of the representative investable European universe can potentially be sustainable. From the USD275.5 billion worth of ineligible assets, approximately USD19.6 billion worth of assets are projected to be stranded, USD38.8 billion are identified as supporting assets, and USD217.1 billion fall into the category of ambiguous assets.

The debate over whether to include nuclear and gas activities in the EU Taxonomy reflects the complex task of finding common ground on sustainability criteria for diverse energy sources across EU member states. The inclusion of these activities as transition technologies acknowledges the regulatory challenge of balancing sustainability goals with the practical constraints of limited low-carbon alternatives.

Our alternative analysis, excluding gas and nuclear assets, highlights the substantial impact of such classifications on the eligibility of European infrastructure assets under the taxonomy. This alternative classification results in a significant drop in eligible assets from 85% to 80%. The notable increase in stranded assets from USD19.6 billion to USD101.1 billion underscores the vulnerability of infrastructure assets under the revised taxonomy. This shift in eligibility is not merely a numerical adjustment but signifies a fundamental change, especially in the IC10 superclass, where eligibility plunges dramatically from 79% to 23%. This sharp decline indicates a major shift in the taxonomy's influence, particularly on non-renewable power generation assets.

It's important to acknowledge that the current EU Taxonomy, while a significant milestone, poses a challenge in terms of interpretation, particularly within the infrastructure sector. As the Taxonomy evolves and matures, there is a growing need for more sector-specific guidance to provide infrastructure investors, asset managers, and asset owners with clear and actionable insights. Infrastructure assets often have multiple functions, making classifying their activities more difficult. Therefore, tailored guidance and additional sector-specific criteria are essential to ensure that the EU Taxonomy is effectively and comprehensively applied within the infrastructure sector, further advancing the integration of sustainability practices into investment decision-making.

This study presents a first step in providing a framework that allows the systematic assessment of the eligibility of a TICCS® asset subclass to the EU Taxonomy. Using this framework, we find that the European infrastructure asset class is predominantly eligible to the EU Taxonomy i.e. these companies can potentially align with the EU Taxonomy and qualify as sustainable investments.

Our analysis of the EU taxonomy shows the limitations of a static list of qualifying activities and thresholds. The EU Taxonomy lists a set of eligible activities across sectors including infrastructure. For each such activity, it proposes a set of quantitative and qualitative criteria and thresholds, upto which eligible activities can be considered aligned. If activities do not fall within those identified as eligible or fail to meet alignment criteria, they would be considered not aligned. In this case, the taxonomy offers no further insights into how the given company can transition and increase its suitability to the taxonomy.

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.

A new joint research initiative between EDHEC*infra*, Private Assets, and the EDHEC-Risk Climate Impact Institute (ERCII) is building a knowledge base of adaptation and resilience technologies that infrastructure companies can implement to reduce their transition and physical risk. This research is critical as currently infrastructure investors have very limited information about effective and cost-efficient ways to decarbonise and increase the climate resilience of their portfolios. Most of the existing studies about decarbonisation and resilience are either targeted geographically (at the city, country, or regional level) with little granularity in their conclusions, or at the engineering design level of individual, isolated projects. Therefore, this initiative will be a crucial first step to close the existing knowledge and information gap between the high-level overview information and the case-specific knowledge, to provide infrastructure investors with usable adaptation and resilience information.

This research will result in the publciation of :

- A database of decarbonisation and resilience technologies applicable to different TICCS classes
- A series of analytical studies on how infrastructure companies can use technology-based solutions to reduce their transition and physical risk

This database called the infraTech database, details, at a TICCS superclass level, the set of primary technologies and strategies that can be used to decarbonise the operations of an infrastructure company or mitigate the physical risks of a changing climate. InfraTech not only identifies the technologies that can be used today i.e. technologies that are currently in the market and are being deployed but also takes a long-term view in identifying (technically and financially viable) technologies that can be implemented as we near the goals and deadlines of international pledges and the Paris Agreement.

In addition to identifying these technologies, infraTech will quantify both the efficacy of individual technologies and present the expected cost of implementing any given technology for different classes of infrastructure companies.

This data collected systematically across infrastructure companies can be used to quantify and compare the transition and physical risk faced by individual companies, as a function of implementation and adoption of specific technologies. For example, as carbon taxation evolves, two airports with similar financials may have different transition risk profiles based on whether they use grid electricity or renewable energy to meet their power requirements. By considering different climate scenarios, this research will be able to provide asset owners and investors with valuable insights into the potential benefits or losses associated with the application of these technologies i.e. how their assets may be impacted amid the challenges posed by climate change and the transition to a low-carbon economy.Thus, by combining data on companies' current performance with their decarbonisation and risk mitigation strategies and plans, we can effectively rate companies on the effective and potential transition and physical risks they face.

In summary, this research initiative by EDHEC*infra* and Private Assets fills crucial knowledge gaps in evaluating infrastructure assets within the EU Taxonomy. By providing a set of practical strategies, our work equips investors with information currently unavailable, facilitating broader goals of decarbonisation, climate adaptation in the transition to a low-carbon economy. In essence, it contributes to advancing sustainable investment practices from a strong evidence base, and underscores the necessity of ongoing research for aligning financial strategies with evolving environmental imperatives.

References

- Blanc-Brude, F. and N. Amenc (2022). The pricing of green infrastructure. *EDHECinfra Research Publication*.
- EDHECinfra (2022). The Infrastructure Company Classification Standard (TICCS®). *EDHEC Infrastructure Institute*. Available at : https://edhec.infrastructure.institute/paper/the-global-infrastructure-company-classification-standard/.
- EU Parliament (2014). Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups. Official Journal of the European Union.
- EU Parliament (2018). Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources. Official Journal of the European Union.
- EU Parliament (2019). Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector. Official Journal of the European Union.
- EU Parliament News (2022). Taxonomy: MEPs do not object to inclusion of gas and nuclear activities. Published: 06 July 2022. Available at: www.europarl.europa.eu/news/en/press-room/20220701IPR34365/taxonomy-meps-do-not-object-to-inclusion-of-gas-and-nuclear-activities.
- European Commission (2023). What is sustainable finance? *The Directorate-General for Financial Stability, Financial Services and Capital Markets Union*. Available at: https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en.
- Eurostat (2023). Energy statistics - an overview. *European Commission*. Available at www.ec.europa.eu/eurostat/statistics-explained/index.php.
- IPCC WG III (2014). Climate change 2014: mitigation of climate change: working group iii. *Fifth assessment repot of the Intergovernmental Panel on Climate Change*.
- Thacker, S., D. Adshead, C. Fantini, R. Palmer, R. Ghosal, T. Adeoti, G. Morgan, and S. Stratton-Short (2021). Infrastructure for climate action. *UNOPS Copenhagen Denmark*.
- Walker, C. (2022). Sustainable infrastructure strong returns hailed as 'proof of concept'. *Imapct Investor*.

Recent Publications (2023-2024)

- Blanc-Brude, F., M. Farid & Abhishek Gupta "Achieving Diversification in Unlisted Infrastructure Investment: Smart Infra Portfolio Construction" (March 2024) Available at: https://scientificinfra.com/paper/achieving-diversification-in-unlisted-infrastructure-investment/
- Orminski, J. "Social Risk Indexing and Rating for Infrastructure Investors: The Case of the UK Water Sector" (March 2024) Available at: https://scientificinfra.com/paper/social-risk-indexing-and-rating-for-infrastructure-investors/
- Amenc, N., F. Blanc-Brude & A. James "Physical Climate Risk Survey: those in the infrastructure investment industry are concerned and lack data" (January 2024) Available at: https://scientificinfra.com/paper/physical-climate-risk-survey/
- Jayles, B. & J. Shen "Computing Extreme Climate Value for Infrastructure Investments: Asset Pricing Applied to NGFS Phase 4 and Oxford Economics Scenarios" (January 2024) Available at: https://scientificinfra.com/paper/Computing-Extreme-Climate-Value-for-Infrastructure-Investments/
- Blanc-Brude, F., A. Gupta & T. Whittaker "Low Tide – Benchmarking Risks in Infrastructure Investments: What the data showed about Thames Water" (January 2024) Available at: https://scientificinfra.com/paper/low-tide/
- Selvam, S. & T. Whittaker "The Valuation of Private Companies: Asset Valuation and the Dynamics of Private Markets" (January 2024) Available at: https://scientificinfra.com/paper/the-valuation-of-private-companies/
- Amenc, N., F. Blanc-Brude, A. Gupta., B. Jayles, D. Marcelo & Jeanette Orminski "Highway to Hell: Climate change will cost hundreds of billions to investors in infrastructure" (September 2023) Available at: https://scientificinfra.com/paper/highway-to-hell/
- Amenc, N., F. Blanc-Brude, A. Gupta., B. Jayles, N. Manocha & D. Marcelo "It's Getting Physical: Some investors in infrastructure could lose more than half of their portfolio to physical climate risks by 2050" (August 2023) Available at: https://scientificinfra.com/paper/its-getting-physical/
- Orminski, J. & J. Shen "Social Impact and Risk Analysis Using Twitter: Measuring Sentiment about Infrastructure Sectors on the Example of Wind Power Generation" (June 2023) Available at: https://scientificinfra.com/paper/social-impact-and-risk-analysis-using-twitter/
- Manocha, N. "Using Taxonomies to Qualify the Sustainability of Infrastructure Investments: Eligibility of the European Infrastructure Asset Class Under the EU Green Taxonomy" (April 2023) Available at: https://scientificinfra.com/paper/using-taxonomies-to-qualify-the-sustainability-of-infrastructure-investments/

These publications are available on our website https://scientificinfra.com/

For more information, please contact:
Nataliia Gaidarenko
e-mail: nataliia.gaidarenko@edhec.edu

EDHEC Infrastructure & Private Assets Research Institute
EDHEC Asia-Pacific
One George Street - #15-02
Singapore 049145
Tel.: +65 6653 8575

EDHEC Europe
10 Fleet Place
London EC4M 7RB
Tel.: +44 20 7332 5601

edhec.infrastructure.institute