OECD Working Papers on International Investment

Cross-border investment into low-carbon infrastructure

An empirical glance

OECD Working Papers on International Investment

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the authors. Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works.

The international investment working paper series – including policies and trends and the broader implications of multinational enterprise – is designed to make available to a wide readership selected studies undertaken under the aegis of the OECD Investment Committee, by OECD staff, or by outside consultants working on OECD Investment Committee projects. Comments on Working Papers are welcomed, and may be sent to martin.wermelinger@oecd.org.or the Investment Division, Directorate for Financial and Enterprise Affairs, OECD, 2 rue André-Pascal, 75775 Paris Cedex 16, France (investment@oecd.org).

OECD WORKING PAPERS ON INTERNATIONAL INVESTMENT
are published on
www.oecd.org/investment/working-papers.htm

Cross-border investment into low-carbon infrastructure: An empirical glance

by

Dirk Röttgers, Iris Mantovani, and Katharina Laengle

The global low-carbon transition requires a tremendous boost in low-carbon infrastructure investment, and cross-border investment has a large role to play. This working paper provides a granular overview of investments into low-carbon infrastructure, both in the real economy and financial market. The descriptive analysis shows that there is room to scale up cross-border infrastructure investment and to shift investment into low-carbon assets. Specifically, low-carbon cross-border investment can be increased by shifting infrastructure investments, that currently flow into the financial economy, to the real economy and by incentivising the use of financing instruments, i.e., securitised products, that bundle projects and meet different liquidity tastes of investors. The analysis also highlights the important role of foreign direct investment (FDI) into infrastructure from foreign real economy companies (i.e., greenfield FDI into infrastructure). To date, greenfield FDI into infrastructure assets are still concentrated in assets that are not low-carbon, especially in more developed countries.

Authorised for release by Carmine Di Noia, Director, OECD Directorate for Financial and Enterprise Affairs.
Keywords: foreign direct investment, greenfield, infrastructure, low-carbon.

JEL codes: F21, Q56, H24, F52.

 This working paper was prepared by Dirk Röttgers, Iris Mantovani, and Katharina Laengle, under the general guidance of Ana Novik, Martin Wermelinger and Robert Youngman. Colene Pouille and Marcia Rocha provided support on visualisation and data management and Valentina Bellesi provided substantial editorial support. Lucinda Pearson and Angele N'zinga provided support during the publication process.

The authors would also like to thank delegates from the OECD Investment Committee and the OECD Working Party on Finance and Investment for Environmental Goals (WPFIEG) of the Environment Policy Committee (EPOC) for their helpful comments. The authors would like to thank the following OECD

colleagues for their support and insight: Pablo Antolin, Kurt van Dender, Perla Iberlucea Flores, Ana Novik, Francesca Spinelli, Aayush Tandon, Stephen Thomsen, Martin Wermelinger, Mamiko Yokoi-Arai and Robert Youngman. The authors are grateful for additional insights by Marie-Theres von Schickfus (ifo Institut) and Markus Zimmer (Allianz SE).

This working paper has been produced in the context of OECD's work on FDI Qualities and contributes specifically to the implementation of the OECD Council Recommendation on FDI Qualities, which aims – among others – to measure the contribution of investment to sustainable development, and particularly to the low-carbon transition. The work is developed jointly by the Investment Division of the OECD Directorate for Financial and Enterprise Affairs, and the Finance, Investment and Global Relations Division of the OECD Environment Directorate.

Table of contents

Cross-border investment into low-carbon infrastructure: An empirical glance 3

Executive Summary 7

1 Why cross-border investment into low-carbon infrastructure matters 9

2 Analytical concepts 11
- 2.1. Definitions of infrastructure and low-carbon 11
- 2.2. Distinction between financial economy investments and real economy investments 12
- 2.3. Scope of the data analysis 13
- 2.4. Context and focus of the data analysis 14

3 Data 16

4 Descriptive results 18
- 4.1. Segment 1: Foreign direct investment in low-carbon infrastructure 18
- 4.2. Segment 2: Cross-border institutional investment in infrastructure 21
- 4.3. Segment 3: Cross-border listed stock investments in infrastructure 28

5 Conclusion and discussion 30

Annex A. Countries and regions covered 32

Annex B. Classification of assets, activities and sectors as low-carbon 34

Annex C. Data cleaning strategies 36

References 41

FIGURES

Figure 2.1. Distinction between financial and real economy investment sources and targets 12
Figure 2.2. Scope and coverage of the empirical analysis 14
Figure 2.3. Focus of analysis and additional context for comparison 15
Figure 4.1. Real economy international investment flows by source and destination 19
Figure 4.2. Real economy international investment flows by sector and low-carbon classification 20
Figure 4.3. Real economy international investment flows by sector and year 21
Figure 4.4. Institutional real economy infrastructure investment holdings by source and destination 23

Figure 4.5. Bilateral cross-border institutional real economy infrastructure investment holdings by source and destination; all and low-carbon 24
Figure 4.6. Bilateral institutional real economy infrastructure investment holdings by source region and destination sector 25
Figure 4.7. Institutional cross-border real economy infrastructure investment by investor and destination sector 28
Figure 4.8. Stock holdings in infrastructure companies 29

Figure C.1. Estimation and attribution process for unlisted funds data 38

TABLES

Table 2.1. Low carbon (sub-)sectors considered in this paper 12
Table 3.1. Overview of data sources for different segments 17
Table 4.1. Shares of low-carbon and other traits in real economy infrastructure investments 18
Table 4.2. Shares of low-carbon and other traits in institutional infrastructure investments 22

Table A.1. Countries and regions in segment 1 32
Table A.2. Countries and regions in segment 2 33
Table B.1. Sectors by segment and infrastructure category 34

Executive Summary

A global economy reliant on fossil fuels and the resulting rising greenhouse gas emissions, now 50% higher than in 1990, are creating drastic changes to Earth's climate. The vast majority of these emissions are caused and determined by the structure of the global infrastructure base, such as the energy or transport systems. Expanding and replacing this infrastructure base with low-carbon infrastructure will be necessary to keep climate goals in reach, such as the well-below 2-degree goal of the Paris Agreement.

Transitioning to a low-carbon infrastructure base will need large amounts of investment in a relatively short time, including cross-border investment. An estimated USD 6.9 trillion per year worth of infrastructure investments are needed through 2030 to meet global infrastructure development and climate objectives simultaneously. However, the gap between the infrastructure investments to be expected under "business as usual" and the aforementioned USD 6.9 trillion is about USD 2.5 to 3 trillion annually. Given the unequal divide of the global economy, cross-border investments will play an important role in this transition.

To formulate policy action towards infrastructure investment goals, it is necessary to have a clear and granular picture of investments. This includes detailed information on the state of low-carbon investments within the infrastructure sector, on the employed financial investment instruments as well as on the countries, regions and investors involved. The framework presented in this paper and the analysis of OECD and G20 infrastructure investments, leveraging multiple commercial datasets, provides a holistic overview on low-carbon infrastructure investments and thereby the foundation for further policy analysis and informed policymaking.

The paper aims to answer the following questions:

- How much cross-border investment into low-carbon infrastructure (such as renewable energy, public transport, and energy efficiency) takes place?
- Which financial instruments are used to make these investments?
- How do investments differ across countries and over time?
- In which sub-sectors are investments being made?
- How do cross-border and low-carbon infrastructure investments compare to investments that are domestic and not low-carbon?

The analysis focusses on the following three major infrastructure investment segments:

- **Segment 1:** foreign direct investments (FDI) into new infrastructure projects, i.e., greenfield FDI infrastructure, as well as cross-border mergers and acquisitions (M&A) in the infrastructure sector **from real economy actors into other real economy actors or assets**; this segment covers investment flows over 2006-2021 from OECD and G20 countries in any other country globally
- **Segment 2:** cross-border investments by institutional investors in real economy assets to give an insight into investment **from the financial economy into the real economy**; this segment covers global holdings of investors in OECD and G20 countries in 2020 (pre-COVID-19)

- **Segment 3:** cross-border investments in stocks of infrastructure corporates to give insights into investments from the **financial economy** into the **financial economy**; this segment covers holdings of any financial investor globally in financial assets located in OECD and G20 countries

The analysis shows that cross-border investments from and into the real economy are particularly important to increase infrastructure investments in low-carbon assets (segment 1). To date, infrastructure investments are not only concentrated geographically but are also concentrated in assets that are not low carbon. Only about 27% of cross-border infrastructure investments are going into low-carbon assets and both investment sources and destinations are concentrated in North America as well as Europe and Central Asia. The need to fill investment gaps in low-carbon infrastructure - especially in emerging markets - highlights the importance of new, i.e., greenfield, cross-border investment in low-carbon assets to spur the green transition.

The results on institutional infrastructure investment, i.e., investment in the real economy made by asset managers, pension funds, sovereign wealth funds and insurance companies (segment 2), show that there is room to scale up and shift infrastructure investment to low carbon projects. Current quantitative regulatory limits on asset allocation do not seem to put an effective limit on low-carbon infrastructure investment as, for example, pension funds and insurance companies in the OECD are currently exploiting only 4% of investments in infrastructure that would be allowed under current regulatory limits. There is thus scope to increase infrastructure investments in general while also shifting investments in low-carbon assets. Unlisted funds, direct project-level equity/debt and securitised products are important instruments to spur green infrastructure investments. Especially securitised products, e.g., YieldCos, INVITs and similar structures, can serve as a pathway to tap investors with a preference for liquid investment products for bundling, scaling up and selling low-carbon infrastructure investment.

Regarding investment holdings in low-carbon infrastructure by financial economy actors in the financial economy, i.e., holdings of listed stocks (segment 3), it becomes apparent that country policy setups do not have an important influence on cross-border investment decisions. Infrastructure investment decisions in the financial economy are more likely made based on exposure and portfolio considerations than environmental considerations with limited impact on carbon-emissions in the real economy. It would therefore be important to find ways to shift infrastructure investments that are currently directed into the financial economy (segment 3) to the real economy (segment 2) through instruments which are equally attractive as investments in listed stocks.

1 Why cross-border investment into low-carbon infrastructure matters

Climate change is one of the defining topics of our time. Ever-rising greenhouse gas (GHG) emissions demand drastic changes of a global economy reliant on fossil fuels. Emissions contribute to more frequent and extreme weather events, land degradation, ocean acidification, and biodiversity loss, among others. On a more intermediated level, climate change causes migration pressures, threats to food security as well as health security, and remains a major threat to biodiversity (World Economic Forum, 2020[1]). The bulk of GHG emissions is caused and determined by the current global infrastructure base (UNOPS, 2021[2]). Scaling up low-carbon infrastructure becomes thus a key element in support of economic resilience, green growth and sustainable development.[1]

Promoting the expansion of low-carbon infrastructure not only offers the opportunity to keep climate targets such as the Paris Agreement's well-below 2-degree goal within reach, but also to reduce the dependence on fossil fuels and the risk of soaring energy prices as experienced in 2022 as a consequence of Russia's war of aggression against Ukraine. Major investments in the expansion of global low-carbon infrastructure will be necessary to achieve these goals.

The combined emissions intensity of existing and planned infrastructure implies that all new infrastructure investments must be aligned with emission reduction targets to avoid missing global climate change commitments (Hepburn et al., 2020[3]; Smith et al., 2019[4]). Transitioning to a low-carbon infrastructure base, before it is too late to achieve these climate goals, requires large public and private investment in a relatively short time.

The analysis in this paper provides an empirical overview and first insights into cross-border investments in low-carbon infrastructure, based on granular data as groundwork for follow-up in-depth policy analyses. For the purpose of this paper, low-carbon infrastructure includes infrastructure such as renewable energy power plants, most forms of public transport and energy efficiency (see Section 3 for a refined definition and Annex B for a list of relevant sectors)[2].

Despite improvements in low-carbon financing, low-carbon investment has a gap to bridge to keep climate goals in reach. Recently, improvements have been made towards more low-carbon infrastructure investments, and the global financial architecture is increasingly taking the challenge to finance a transition to a low-carbon economy seriously (TCFD, 2022[5]; GFANZ, 2022[6]). However, an estimated USD 6.9 trillion per year worth of infrastructure investments are needed through 2030 to meet needs for global infrastructure development and climate objectives simultaneously (OECD/The World Bank/UN Environment, 2018[7]). The gap between these USD 6.9 trillion and the infrastructure investment, that can be expected under business as usual, are some USD 2.5-3 trillion annually (ibid). Despite infrastructure cost-reductions achieved through technological advancement, infrastructure investment continues to fall short of annual needs, enlarging the aggregate investment deficit. Infrastructure investment tends to be considered a public sector "business" but other economic actors like institutional investors, e.g., pension funds or insurances, private investors, or multilateral development banks need to be mobilised to fill investment gaps (World Bank, 2019[8]).

The bulk of investments are needed in emerging and developing countries (NCE, 2016[9]). Comparable to the overall USD 6.9 trillion needed annually, emerging Asia[3] *alone* needs investments of USD 1.7 trillion

yearly to ensure sustained socio-economic development (Asian Development Bank, 2017[10]). Moreover, infrastructure investment needs in power, water supply and sanitation, ICT and transport in Africa are estimated to range between USD 130-170 billion per year for the 2016-2025 period (African Development Bank, 2018[11]). With 60% of global population projected to live in urban areas by 2030, and most of those living in in emerging and developing countries, 60% of global urban infrastructure needed is yet to be built (UN, 2018[12]).

In view of diverting financial capacities of countries to finance a low-carbon transition, foreign direct investment (FDI) can bridge investment gaps by providing the necessary financial and technological resources. Developing and emerging countries that face greater financing constraints may draw particular benefits from attracting FDI in low-carbon infrastructure. The extent to which FDI contributes to financing low-carbon infrastructure will depend on several framework conditions, including the market and regulatory environment as well as specific policies designed to promote low-carbon infrastructure investment (OECD, 2022[13]). Private funds, in particular, are generally available even despite recent changes in inflation rates and the associated shifts in investment behaviour. However, overcoming investment barriers and attracting investment in low-carbon infrastructure often needs a change in policy.

Although investment in low-carbon infrastructure across all economies experience an increased interest, the underlying reasons for making these investments as well as their sources and barriers are often not clear. To formulate policy action, it is necessary to know and react to often differing and non-obvious circumstances. For example, investment in low-carbon infrastructure often differs in terms of financial instrument used, deal size and other factors from established infrastructure investment paradigms for other infrastructure. While often perceived as mere details, these details can matter greatly to investors and developers. More detailed information on both types of investments enables more targeted policy-making both for investments in general and low-carbon investments in particular.

The following analysis, and discussion of OECD and G20 infrastructure investments will provide an empirical overview as foundation for further policy analysis and informed policymaking. Among others, the analysis aims to answer the following questions:

- How much has been invested into low-carbon infrastructure across borders?
- How do investments differ across countries and over time?
- Which financial instruments have been used to make these investments?
- In which sub-sectors have these investments been made?
- How do these investments compare to domestic investments and investments that are not low-carbon?

With these questions, the paper aims at identifying scope for effective policy measures to scale up infrastructure investments in general and infrastructure in low-carbon assets in particular.

These questions are answered based on three subsamples of relevant infrastructure investments. Building a comprehensive dataset is not feasible given the lack of data, for example on investments by commercial banks (as e.g. analysed in Rainforest Action Network (2021[14])) or corporate bonds (for a detailed discussion see (OECD, 2023[15])). However, the data presented in this paper either covers representative sections or illustrative subsamples, which aim to give instructive insights into cross-border low-carbon infrastructure investment.

The remainder of this paper is divided into four sections. The following Section 2 outlines analytical concepts, Section 3 provides details on data while Section 4 presents descriptive results. Section 5 concludes and discusses how the underlying data for this analysis can feed into an in-depth policy analysis of the impact and interplay of low-carbon policies and investment policies to shift and scale-up cross-border low-carbon investment.

2 Analytical concepts

This section outlines the analytical concept, the scope, and the context of the analysis. Section 2.1 defines the terms infrastructure and low carbon in the context of this paper. Section 2.2 distinguishes between financial and real economy investments, using the concept of infrastructure investment segments defined above. Section 2.3 provides further details on which actors and sectors are considered within the segments. The last sub-section sets out the comparative context in which these different segments are analysed in this paper.

2.1. Definitions of infrastructure and low-carbon

2.1.1. Definition of infrastructure

In the context of the OECD Horizontal Project on Sustainable Infrastructure, the following definition of infrastructure is used (OECD, 2021[16]):

Infrastructure is the set of fundamental facilities and systems that support the provision of goods and services essential to enable, sustain, or enhance societal living conditions and protect the surrounding environment from erosion and other disasters that reduces the usefulness for economic purposes.

The set of fundamental facilities and systems are composed of public and private physical structures as well as intellectual property products supporting the effective operation of these structures.

The following functions are considered to be provided by economic infrastructure: transport; utilities (provision of energy, water, and sanitation and waste management); flood protection and water management; and IT and communications.

Social infrastructure relates to the provision of the following functions: education; health; public order and safety; culture; and recreation.

Following OECD (2020[17]), the analysis in this paper is guided by this definition, with an emphasis on including sectors, types of physical assets and types of listed corporates commonly understood by the financial sector as infrastructure. In financial sector terms, these assets are part of the *"infrastructure asset class"*.[4]

Further, nature-based infrastructure such as ecosystem services like water filtration from catchment areas are excluded here as well. For a detailed list of which sectors are included in the analysis and how existing classifications in the underlying commercial databases are merged, see Annex B.

2.1.2. Definition of low-carbon

As there is no universally accepted definition of low carbon, this analysis is guided by efforts of the OECD (2020[17]) to provide infrastructure data.[5] Based on OECD (2020[17]) as well as the available lowest disaggregation-level categories of available databases, the most notable categories include, among others, all forms of renewable power such as wind and solar power, all forms of public transport except air travel as well as energy efficiency. Importantly, neither this paper nor OECD (2020[17]) include nuclear

power infrastructure as low-carbon. Table 2.1 provides an overview of low-carbon (sub-)sectors considered in this paper. For a detailed list of sectors and sub-sectors included as low-carbon, see Annex B.[6]

Table 2.1. Low carbon (sub-)sectors considered in this paper

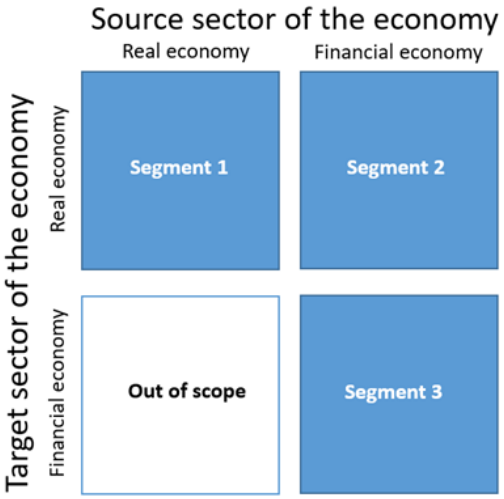
Infrastructure category	Low-carbon
Energy	Bioenergy; Energy efficiency; Geothermal; Hydro power; Marine electric power; Solar power; Wind power, other renewable energy.
Transport	Rail transportation; Transit and ground passenger transportation; Railway operators.

Note: This tables provides an overview of different low-carbon infrastructure assets that are considered in this analysis. Other infrastructure categories like Telecommunications, Water, Waste management and Social are considered without any specific low-carbon assets. Annex B provides a detailed list in which context different low-carbon infrastructure assets are considered.
Source: Based on data sources described in Section 3.

2.2. Distinction between financial economy investments and real economy investments

In the context of a low-carbon infrastructure policy discussion, it is important to distinguish **financial economy investments** from **real economy investments** (Jachnik, Mirabile and Dobrinevski, 2019[18]; OECD, 2020[17]). To have an impact on the transition to low-carbon infrastructure, finance and investment has to have a downstream impact (or ***real economy*** impact), i.e. it has to lead to investments either in new physical infrastructure assets or in refurbishment of old physical infrastructure assets. The effect of ***financial economy*** investments, however, is, if anything, indirect and evidence on the degree of its impact is scarce. Therefore, this analysis, assuming that real economy investments are more relevant to a policy discussion, distinguishes between investments ***from the real economy and from the financial economy to the real economy*** (e.g., through project-level investment or investment in private equity funds) and ***from the real economy into the financial economy*** (e.g., through trading stocks). Figure 2.1 provides an overview of these three segments and their respective coverage.

Figure 2.1. Distinction between financial and real economy investment sources and targets



Note: Investments of real economy actors into the financial economy are relatively rare, generally not systematic, and therefore negligible. Accordingly, they are out of scope of the analysis here.
Source: Authors.

While the distinction between real and financial economy may not be sharp in all cases, the definition of gross fixed capital formation used for national accounts is a good approximation for what falls under real economy (Jachnik, Mirabile and Dobrinevski, 2019[18]). In this context it should be acknowledged though that in recent years the distinction has become less and less sharp given investor activity and engagement with investee companies. Financial actors aim to actively influence investment decision regarding physical assets held through e.g. liquid financial instruments such as corporate stocks. However, while anecdotal evidence exists, systematic evidence of the effect of this burgeoning investor stance on low-carbon investment is scarce so far.

For investments to support climate change mitigation efforts, they need to have an effect as direct and immediate as possible. To make this distinction as clear as possible, this paper distinguishes between investments in the financial economy and those in the real economy along the lines of investment sources and investment instruments/targets. While participation in primary issuances of corporate stocks (i.e., an *initial public offering*) may provide finance for new asset creation, stock investments in the secondary market (e.g., at stock exchanges) do not provide additional capital to the company concerned. In theory, this secondary market activity changes the capital cost of stocks related to low-carbon infrastructure (Heinkel, Kraus and Zechner, 2001[19]), but no empirical estimation of the size and directness of this effect exists. Accordingly, Section 3 describes the data uses in this paper in each of the three segments as outlined in Figure 2.1.

2.3. Scope of the data analysis

As limited data availability prohibits an all-encompassing analysis of different kinds of infrastructure financing, this paper focuses on the analysis of three representative and illustrative segments to provide instructive insights into cross-border investment into low-carbon infrastructure.

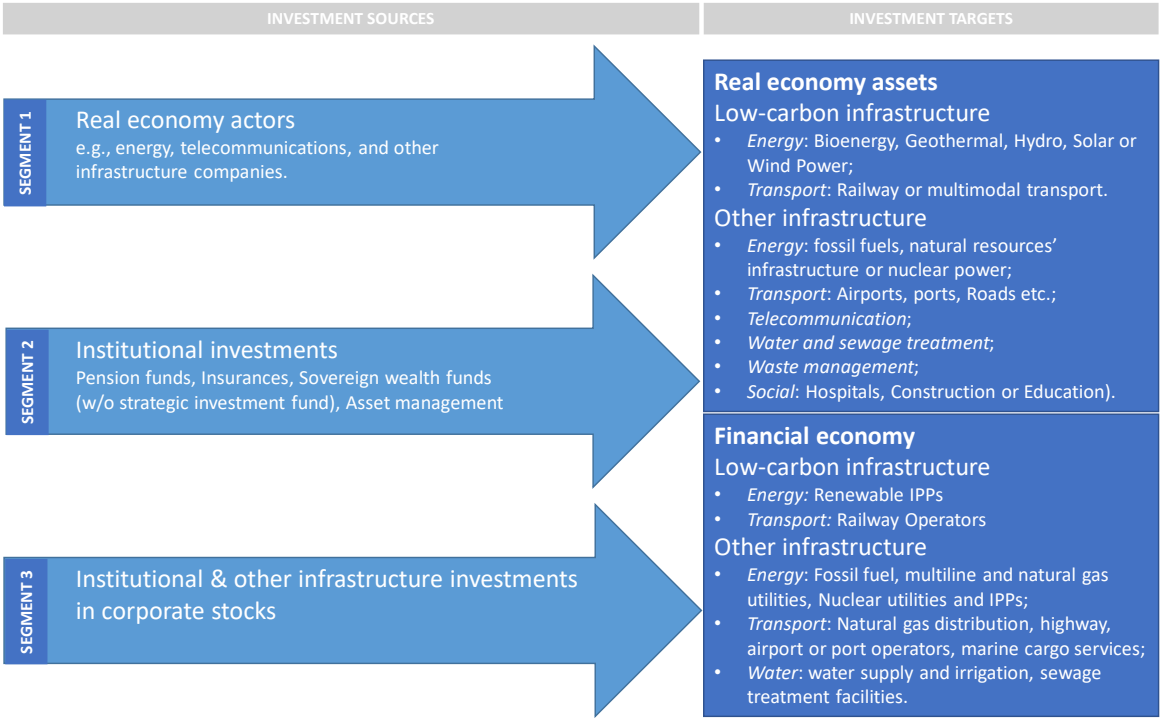
Segment 1 covers direct cross-border investments from **real economy actors into real economy** assets in the form of **cross-border mergers and acquisitions** as well as **other direct cross-border infrastructure investments, i.e., greenfield FDI**. It describes a straightforward way of acquiring infrastructure abroad for own business activities. These acquisitions, which directly relate to infrastructure business activity, can naturally be expected to play a large role in developing infrastructure and therefore in developing low-carbon infrastructure. These investments are generally made by real economy actors such as energy, telecommunications, and other infrastructure companies. Technically commercial banks, investment banks, asset managers and other institutional investors could (and occasionally do) make these investments as well, but they would typically only have a minority stake and therefore the distinction is ignored here.

Segment 2 covers **cross-border institutional investments**[7] in real economy assets to give an insight into investment from the **financial economy into the real economy**. It reflects the role that institutional investment can and currently does play in global infrastructure development. The role and potential of institutional investment is well documented (Della Croce, 2014[20]; Röttgers, Tandon and Kaminker, 2018[21]; Della Croce, 2011[22]). Several organisations, including the OECD, have further identified and analysed the modalities to direct institutional capital towards infrastructure (OECD, 2015[23]; Inderst, 2016[24]; Nelson and Pierpont, 2013[25]; Della Croce and Yermo, 2013[26]; Youngman and Kaminker, 2016[27]; Inderst, 2016[28]; Kaminker, 2016[29]; G20/OECD, 2013[30]). These analyses particularly point out institutional investors' role as 'recyclers of capital', taking operational assets off balance sheets of short-term financiers such as developers and commercial banks, thereby freeing up capital for new investment.

Segment 3 covers **cross-border investments** to give an insight into investments from the **financial economy into the financial economy** focussing on the largest type of investor in terms of assets under management. It shows the state of infrastructure investment through an analysis of listed shares of infrastructure corporates. Although the impact on GHG emissions from these investments is theoretically and practically less direct compared to investments of the other segments, this segment is still worth analysing. It comprises a large part of overall investments in global financial markets and represents the bulk of infrastructure financing, as a large part of infrastructure assets are held by listed companies.

Figure 2.2 summarises the investment sources and targets considered in this paper.

Figure 2.2. Scope and coverage of the empirical analysis



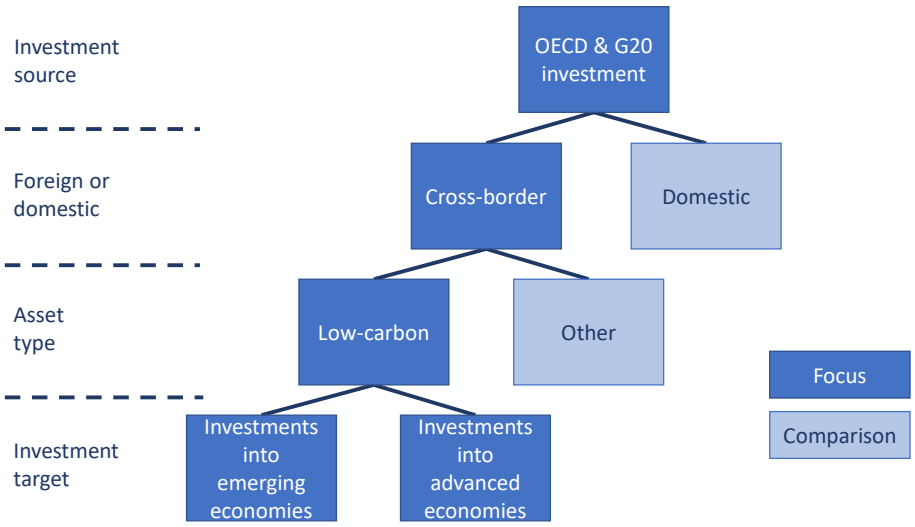
Source: Authors.

2.4. Context and focus of the data analysis

For segments 1 and 2, i.e., infrastructure investments from the real and the financial economy into the real economy, the empirical overview presented in this working paper covers infrastructure investment from OECD and G20 source countries into all possible destination countries. Segment 3, i.e., infrastructure investments from the financial economy into the financial economy, considers investments from all possible sources into OECD and G20 destinations. See Section 3 for further details.

To put the scale of investment in low-carbon infrastructure in context, the empirical analysis compares domestic and cross-border investment, and low-carbon and all (non-low-carbon and low-carbon) investment whenever possible and informative (Figure 2.3).

Figure 2.3. Focus of analysis and additional context for comparison



Note: This diagram provides an overview of the focus of analysis and its context. It should be noted that the scope of sources and investment targets differs across segments. Segments 1 and 2 focus on investment by OECD and G20 economies in global destinations (as depicted in this diagram) while segment 3 focuses on global sources investing in OECD and G20 destinations.
Source: Authors.

3 Data

A targeted examination of the questions posed in Section 1 requires granular data of infrastructure investments. Such data is available, but fragmented throughout multiple commercial databases, and are supplemented by primary data[8] collection and statistical techniques to fill data gaps where feasible and useful.

Data for the three segments analysed in this paper largely stem from 5 databases as well as primary research (Table 3.1). Data for segment 1 on cross-border mergers and acquisitions stem from Refinitiv (2022[31]) and on other direct cross-border investments from Financial Times (FT) fDi Markets (Financial Times, 2022[32]). Data for segment 2 on institutional investment into real economy infrastructure (excluding direct institutional investments in corporate stocks or bonds) are mainly sourced from Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research. These data were originally prepared for OECD (2020[17]), and amended to provide a more granular view in this paper, as described in Annex C. Data for segment 3 on investments in corporate stocks stem from Refinitiv (2022[31]). Due to the availability of data, segments 1 and 2 are based on data focusing on OECD and G20 countries as source and global destinations while segment 3 considers global sources and OECD and G20 countries as destinations.

For segments 1 and 2, i.e., infrastructure investments from the real and financial economy into the real economy, the empirical overview presented in this working paper covers infrastructure investment ***from OECD and G20 source countries into all possible destination countries*** (see Annex A). For Segment 1, i.e., real economy investment data, these analysis covers 52 countries, since they include OECD member countries as of 2022 as well as Hong Kong (China), as a separate jurisdiction from the People's Republic of China, whereas for institutional investment data, i.e. segment 2, this includes 49 countries, i.e. OECD member countries as of 2019 (out of which 10 are excluded since no investments were recorded). Segment 3, i.e., investments from the financial economy into the financial economy, instead focuses on investments ***from all possible source countries to OECD and G20 destination***.

It is important to note some caveats when interpreting descriptive results. First, the analysis considers investment ***flows***, i.e., new investments and transactions made over a year (segment 1), as well as investment ***holdings***, i.e., the net stock of investments and divestments accumulated over time through underlying flows (segments 2 and 3). While both, flows and holdings, are relevant for analysing investment patterns and the impact of policies, the data does not always allow for the same granular insight or for viewing the data through the same lens. Segment 1 considers investments based on flow data as this consideration corresponds to the format of the available data. Converting these flows to holdings, i.e., aggregating investments to obtain a value for holdings, would have led to possible inconsistencies with other holding data presented in this paper, as divestments were not recorded.

Second, the data also differ in how comprehensively they provide a picture, making it difficult to compare the data sets underlying the three segments. Differences in comprehensiveness are largely due to how complete the available data are, and how much it allows producing a comprehensive picture e.g., by applying statistical methods. Information on mergers and acquisitions as well as on greenfield foreign direct investment (FDI) are often lacking investment values and provide little additional information for a reasonable estimation to replace missing values. Therefore, the investment values of segment 1, i.e., investments from and into the real economy, could be considered as a lower bound rather than a point estimate.[9] Institutional investment data used in segment 2 from OECD (2020[17]) were curated and

processed using statistical methods to provide a comprehensive picture, which was possible due to available auxiliary data (see Annex C for details). Financial sector data used in segment 3 from Refinitiv allow a somewhat comprehensive picture at least for large investors since it is publicly traded and therefore information is already in the public domain and can be expected to have been recorded well.

Table 3.1. Overview of data sources for different segments

Segment Nr.	Focus of analysis	Type of data used	Measure	Data source	Country scope	Considered Time
1	From **real economy** to **real economy**	Cross border M&A	Flows	Refinitiv (2022[31])	Sources: OECD and G20; Destinations: global	2006-2021
		Direct cross-border greenfield investment	Flows	FT fDi Markets (2022[32])		
2	From **financial economy** to **real economy**	Institutional investment in infrastructure (excluding direct institutional investment in corporate stocks or bonds)	Holdings	Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.	Sources: OECD and G20; Destinations: global	2020
3	From **financial economy** to **financial economy**	Investments in corporate stocks	Holdings	Refinitiv (2022[31])	Sources: global ; Destinations: OECD and G20	2022

Source: Authors.

The limited availability of data on infrastructure investment remains an obstacle to empirical infrastructure analysis. This includes missing data on undisclosed bond ownership[10], use of proceeds and by extension structured debt products as well as undisclosed deal values of mergers and acquisitions or undisclosed capital expenditure of new projects.

Where overlaps of data and double-counting are concerns, they are avoided by collecting data at a disaggregated level. At a disaggregated level distinctions are easily made given the granular information on investors, sectors, and other details. After double-counting is checked and removed if present, the data is aggregated to the level presented in Section 4. For details on data treatment including double-counting, the merging of databases as well as statistical techniques used to fill data gaps, see Annex C. Annex A also contains the list of countries covered in this report and their assignment to regions, which are different between the segments.

Third, some of the data have a substantial time lag, and therefore have to be interpreted with caution with respect to crises of recent years. The data for all segments are from before the energy crisis and related increases in interest rates, and the data for segment 2 in addition are from before the Covid crisis. While the Covid crisis certainly had short term effects on infrastructure investments by long-term investors, it is not clear at the time of writing if investment patterns changed in the medium or long term. For the energy crisis and rises in interest rates, however, it is likely that investment patterns will change. Whereas before private capital was available and seeking investment opportunities, the picture will have changed by now at least to some degree. Given that much of the infrastructure analysed here is energy infrastructure, however, the effect of the energy crisis could run counter to any effects interest rates have on investment patterns. The crises could even increase investment in energy infrastructure. Future analyses will have to answer the question if this goes along with a shift to low-carbon energy infrastructure as well. In general, however, investment patterns in infrastructure were more robust to crises than investment patterns in other sectors, which would point towards the continued validity of insights produced here.

4 Descriptive results

4.1. Segment 1: Foreign direct investment in low-carbon infrastructure

Figures in this subsection on segment 1, i.e. infrastructure investment from and into the real economy, represent overall FDI of about USD 6 trillion, split between greenfield FDI,[11] i.e. direct cross-border investment in physical assets, and mergers and acquisitions.[12] [13] Only about one quarter of all greenfield FDI projects in infrastructure are low-carbon (26%), while being almost absent in the cross-border M&A subsample (1%); see Table 4.1.

Table 4.1. Shares of low-carbon and other traits in real economy infrastructure investments

Real economy only (Segment 1)	Low-carbon	Non low-carbon	Total in pooled sample
Mergers & Acquisitions	About 1%	About 43%	About 44%
Greenfield FDI	About 26%	About 20%	About 56%
Total	About 27%	About 63%	100%

Source: Authors based on Refinitiv (2022[31]) and FT fDi Markets (2022[32]).

Most ***FDI in overall infrastructure originates*** in Europe and Central Asia (61%), with Spain (10%), France (8%), Germany (8%) the United Kingdom (8%), and Italy (5%) leading among countries of those regions (Figure 4.1, Panels A). A distant second region is North America (18%), with the United States (12%) leading before Canada (6%) in terms of total observed investment. A noteworthy third place among regions is East Asia Pacific (14%), with China (6%) leading before Japan (5%). South Asia accounts for about 2% of FDI in infrastructure as an investor, with India as the region's leading FDI investor country, while the regions Latin America and the Caribbean, the Middle East and North Africa, as well as Sub-Saharan Africa each account for about 1%.

The distribution of ***FDI in low-carbon infrastructure*** by origin is vastly skewed towards a few regions and countries (Figure 4.1, Panels A). Europe and Central Asia accounts for 83% of low-carbon infrastructure FDI with Germany contributing about 71% of low-carbon infrastructure FDI. The remaining 17% of FDI in low-carbon infrastructure stems from the East Asia Pacific region (10%), driven by Japan (10%), as well as Latin America and the Caribbean (7%) driven by Chile (7%). Although North America accounts for about 18% of total infrastructure FDI, the region barely shows any FDI in low-carbon investment (0.15%).

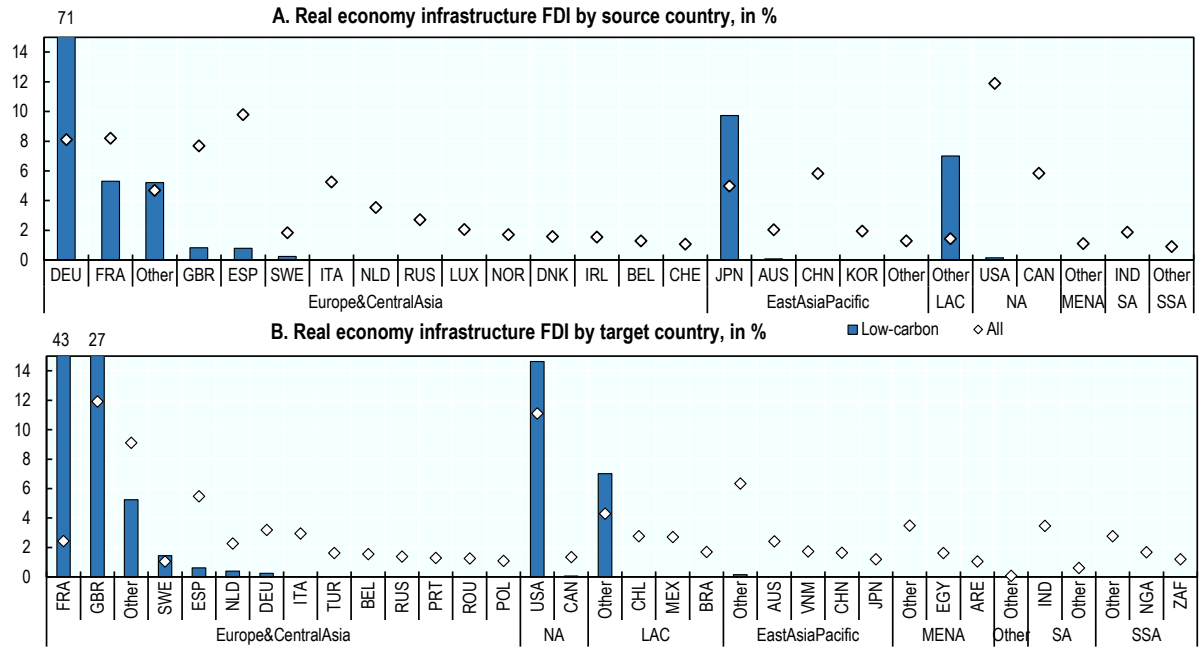
The Europe and Central Asia region also ranks first as ***target of overall, i.e., non-low-carbon and low-carbon, infrastructure FDI*** (47%) with the United Kingdom (12%) as most important recipient followed by Spain (5%), Germany (3%), Italy (3%), France (2%) and the Netherlands (2%) (Figure 4.1, Panel B). The East Asia Pacific region ranks second among regions (13%), with Australia taking first place within the region in a more balanced field. With just under 13% of overall infrastructure FDI, North America ranks third among recipient regions of total infrastructure FDI most notably driven by the United States (11%)

representing the second largest destination country of overall infrastructure FDI. Further infrastructure FDI flows into the Latin America and the Caribbean (11%), Middle East and North Africa (6%), Sub-Saharan African (6%) and South Asian regions (4%).

As the distribution of sources, ***investment target regions and countries of low-carbon infrastructure FDI*** are skewed towards a few destination regions and countries. The Europe and Central Asia region accounts for 78% with France and the United Kingdom together accounting for 70%. About 15% and 7% of global low-carbon infrastructure FDI flows to North America and Latin America and the Caribbean, respectively, with the United States and Peru being the main recipients. Although the East Asia and Pacific region ranks second in terms of total infrastructure FDI inflows, the region received only a minute proportion of 0.1% of global low-carbon infrastructure FDI. While some of the stark difference may be exaggerated because of data gaps in both underlying datasets, the overall tendencies are likely reflecting real investment patterns. Where data is more readily available, e.g., for domestic investments, similar differences between overall and low-carbon investments can be shown (OECD, 2020[17]).

Figure 4.1. Real economy international investment flows by source and destination

Aggregated over the years 2006-2021 across OECD and G20 sources and global destinations, blue bars = % of low carbon infrastructure investment, diamonds = % of all infrastructure investment



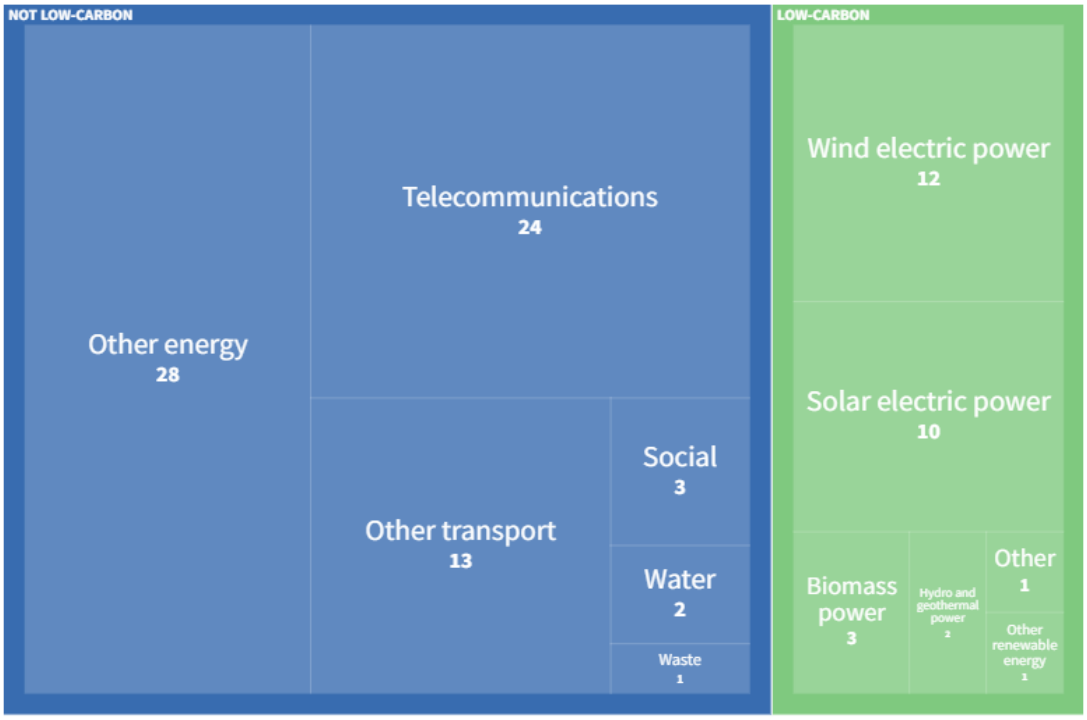
Note: These charts show real economy infrastructure FDI aggregated over the years 2006-2021 by source and destination countries. Values are captured as shares by country as source or destination in all (low-carbon and non-low-carbon) infrastructure FDI (diamonds) and low-carbon infrastructure FDI (bars). Panel A presents real economy infrastructure FDI by source while panel B presents real-economy infrastructure FDI by destination. Source countries include OECD and G20 countries. Sources and destinations that account for less than 1% of all (low-carbon and non-low-carbon) infrastructure FDI are summarized as "Other". LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, NA = North America, SA = South Asia, SSA = Sub-Saharan Africa.
Source: Authors based on Refinitiv (2022[31]) and FT fDi Markets (2022[32]).

In terms of the sectoral distribution of infrastructure FDI, only a small share of investment flows into low-carbon infrastructure (Figure 4.2).[14] Between 2006 and 2021, low-carbon sectors account for just over a quarter of infrastructure FDI (about 27%) and even becomes negligible when only considering mergers &

acquisitions (Figure 4.2 and Table 4.1). Most low-carbon infrastructure FDI flows into wind (12%) and solar (10%) electric power followed by biomass power (3%) as well as hydro and geothermal power (2%).

Figure 4.2. Real economy international investment flows by sector and low-carbon classification

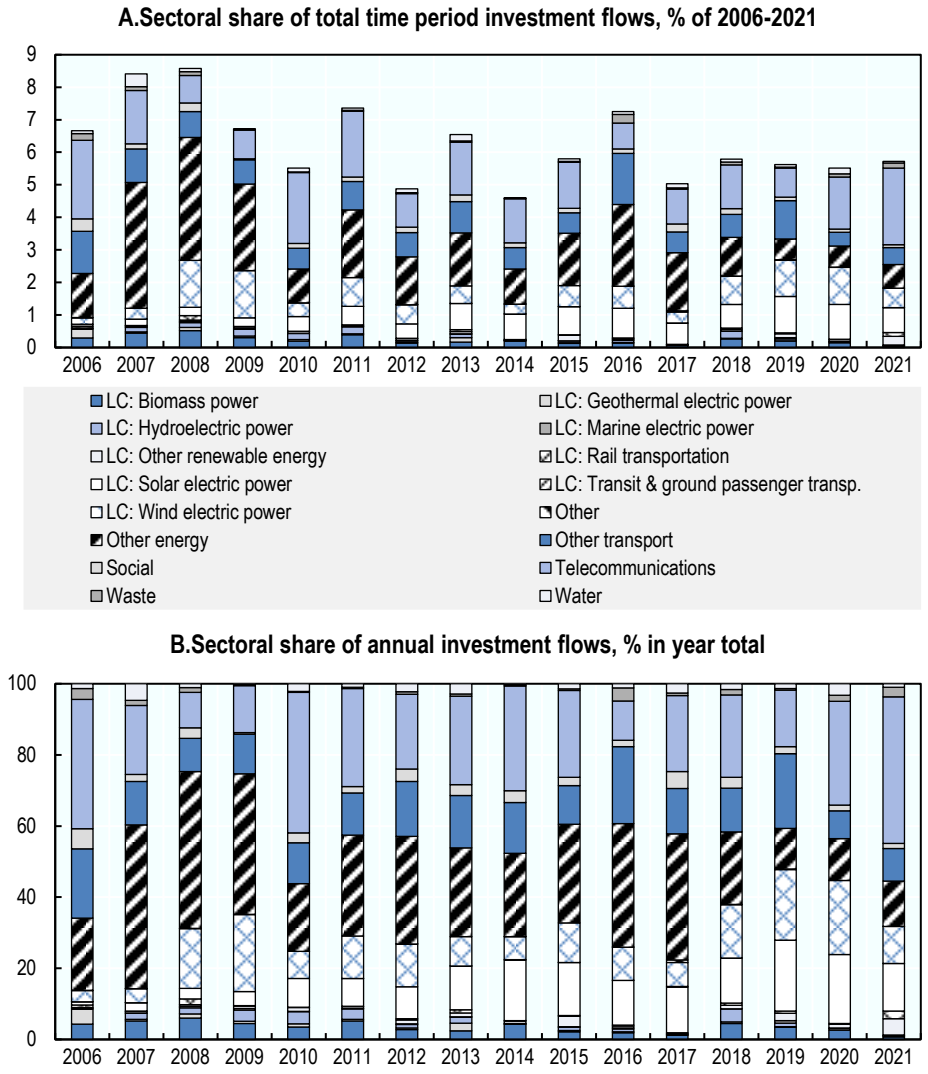
Aggregated over the years 2006-2021 across OECD and G20 sources and global destinations, in % of total



Note: This chart shows real economy infrastructure FDI by sector and low-carbon classification aggregated over the years 2006-2021 by OECD and G20 source countries to global destinations. Low-carbon infrastructure FDI "Other" includes Marine electric power, Rail transportation as well as Transit & ground passenger transportation.
Source: Authors based on Refinitiv (2022[31]) and FT fDi Markets (2022[32]).

Taking a closer look at the overall investments as well as distribution of sectors over time in Figure 4.3 shows that investments have peaked in 2008 and have not recovered to that level in the years since. The composition has changed drastically in favour of low-carbon investments in recent years. Wind power investments have become a mainstay since 2008, followed by solar power investments in 2013. Notably, this renewable energy development did not coincide with lower overall investments in fossil fuel-based power infrastructure (aggregated here within *other energy*), where clear drops in investment are only showing in very recent years.

Figure 4.3. Real economy international investment flows by sector and year



Source: Authors based on Refinitiv (2022[31]) and FT fDi Markets (2022[32]).

4.2. Segment 2: Cross-border institutional investment in infrastructure

Figures in this section on segment 2 represent overall infrastructure investments of at least USD 1 trillion of four types of institutional investors, i.e., asset managers, pension funds, sovereign wealth funds and insurance companies. These investments are split between several major financial investment instrument categories. These infrastructure investments are divided between cross-border (51%) and domestic investments (49%), and between low-carbon (27%) and other investment (73%) (Table 4.2).[15]

The split of low-carbon institutional investments between cross-border (20%) and domestic investments (7%) suggests that institutional investments are more likely to be low-carbon if they are made across borders. When closing the investment gap in infrastructure, cross-border investments thus offer the potential to spur the green transition, and institutional investors could be an important source of these investments.

In total values, the investments have the potential to be substantially higher. The institutional infrastructure investments of USD 1 trillion represent only a small fraction of what OECD and G20 institutional investors

are theoretically allowed to invest in infrastructure. For example, for OECD pension funds and insurance companies, green investments represent less than 4% of their assets under management (AUM), i.e., only 4% of what institutional investor could theoretically invest in infrastructure (OECD, 2020[17]). This means that – considerations regarding diversification, portfolio concentration and fiscal stability aside – quantitative regulatory limits on asset allocation do not put an effective limit on expanding low-carbon infrastructure investments. Pension funds and insurance companies are allowed to invest more in low-carbon, making incentives for these investments even more important as a target for low-carbon investment policymaking.

Table 4.2. Shares of low-carbon and other traits in institutional infrastructure investments

Institutional Investment (Segment 2)	Low-carbon	Non low-carbon	Total
Cross-border	20%	31%	51%
Domestic	7%	42%	49%
Total	27%	73%	100%

Source: Authors based on Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.

Institutional investors based in the United States hold 43% of ***all domestic and cross-border infrastructure investment***, and, together with Canada, account for 60% of holdings in this segment (Figure 4.4, Panel A). Further notable investor regions are Europe and Central Asia as the second largest investor region at 27%, followed by the United Kingdom (9%), and East Asia Pacific as the third largest investor region at 9%, followed by Australia at 5%. All other countries represent 3% or less, including China with 2.6%. Anglo-Saxon countries dominate institutional infrastructure investments in this segment, as their pension systems, unlike e.g., the German and French pension systems, tend to rely heavily on pension funds and are home to some of the largest asset managers and more generally strong financial industries (OECD, 2023[35]).

Shares among regions and countries are more evenly distributed when considering ***cross-border low-carbon infrastructure investment*** (Figure 4.4, Panel A). Regarding institutional cross-border investments in low-carbon infrastructure, 44% of institutional investors are located in North America tightly followed by Europe and Central Asia (42%) as well as East Asia Pacific (11%). Within North America the share of institutional low-carbon infrastructure investment holdings is equally split among the United States and Canada while the United Kingdom (13%), Germany (9%) and Denmark (6%) represent the largest source countries in the Europe and Central Asia region. China represents the largest source country for cross-border investments in low-carbon infrastructure in East Asia Pacific (6%).

The distribution of investment sources is broadly reflected in the distribution of investment destinations (Figure 4.4, Panel B). Among investment destinations, the United States hosts more than half of domestic and cross-border investments in infrastructure (52%), so that the North American region holds 55% of global institutional infrastructure investments followed by the United Kingdom that receives 12% and, together with France, Germany, the Netherlands, Spain and other countries of the Europe and Central Asia region accounts for a total of 29%. The remaining 16% of OECD/G20 institutional investments in infrastructure are hosted by East Asia Pacific (9%) with Australia accounting for 6% while Latin America and the Caribbean host 4% and South Asia, Sub-Saharan Africa as well as Middle East & North Africa account for about 1% respectively.

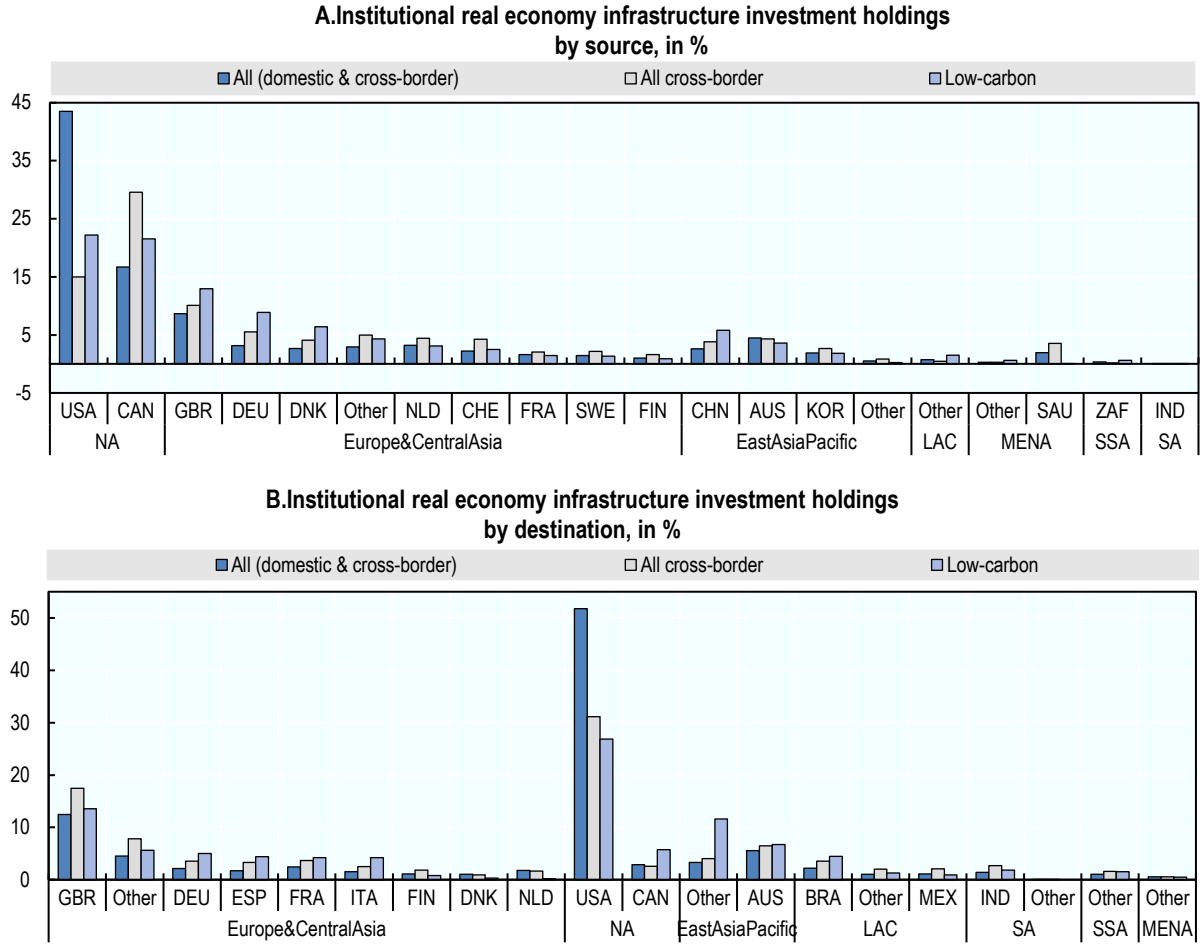
The host countries' shares of institutional cross-border investments in low-carbon infrastructure are more evenly distributed across regions and countries than total domestic and cross-border investments. Although the United States also represent the largest destination for institutional cross-border investments in infrastructure (27%), the Europe and Central Asia region (38%) hosts a slightly larger share of institutional cross-border investments in low-carbon infrastructure than North America (33%) and East Asia

Pacific (18%). Compared to the distribution of total domestic and cross-border institutional infrastructure investments, other regions also increase their shares, albeit only slightly, e.g., East Asia Pacific with 18% and Latin America and the Caribbean with 7% mostly driven by Brazil (4%).

Institutional cross-border investments in low-carbon infrastructure and cross-border infrastructure in general do not differ substantially. This can be interpreted as openness to cross-border infrastructure investment both as a source as well as a destination country being a good predictor of low-carbon infrastructure investments. The notable differences are the switches in ranks within European countries both on the source and destination side, as well as the increased prominence of Brazil as a destination.

Figure 4.4. Institutional real economy infrastructure investment holdings by source and destination

For the year 2020 across OECD and G20 sources and global destinations



Note: These charts show institutional real economy infrastructure investment holdings by OECD and G20 sources and global destination for the year 2020. "Low-carbon" stands for low-carbon cross-border investment. Sources and destinations that account for less than 1% of all infrastructure FDI are summarized as "Other". LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, NA = North America, SA = South Asia, SSA = Sub-Saharan Africa.
Source: Authors based on Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.

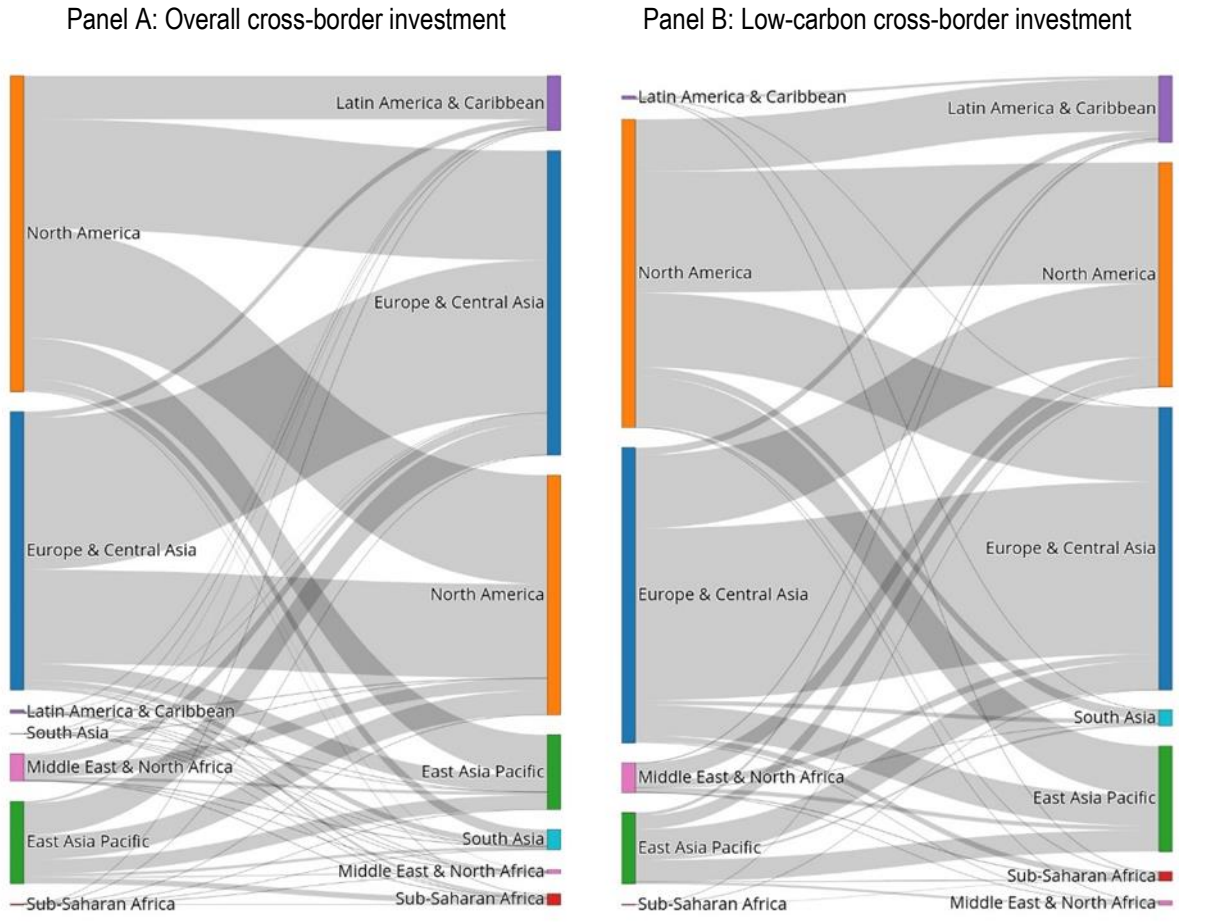
Institutional infrastructure investments in segment 2 are mostly financed by institutions within the same region. For both total and low-carbon infrastructure cross-border investment in North America as well as in Europe and Central Asia, intra-regional flows account for the largest share of investment flows

(Figure 4.5). Especially for low-carbon infrastructure investment hosted in Europe and Central Asia, intra-regional flows are particularly important (Figure 4.5, Panel B). While North America and Europe and Central Asia represent each other's second largest source of institutional infrastructure investment for both total and low-carbon infrastructure investment, the mutual importance slightly weakens in the context of low-carbon infrastructure investments. Instead, institutions in North America hold a larger share of their low-carbon infrastructure investments in Latin America and the Caribbean as well as in East Asia Pacific while institutions in Europe and Central Asia hold a comparatively larger share in East Asia Pacific.

Institutions in East Asia Pacific, Latin America, and the Caribbean as well as in Africa have a less diversified set of destination regions for low-carbon investments relative to infrastructure investments in general. For example, low-carbon infrastructure investments from East Asia Pacific concentrate more strongly on Europe and Central Asia as well as on the region itself.

Figure 4.5. Bilateral cross-border institutional real economy infrastructure investment holdings by source and destination; all and low-carbon

For the year 2020 across OECD and G20 sources and global destinations

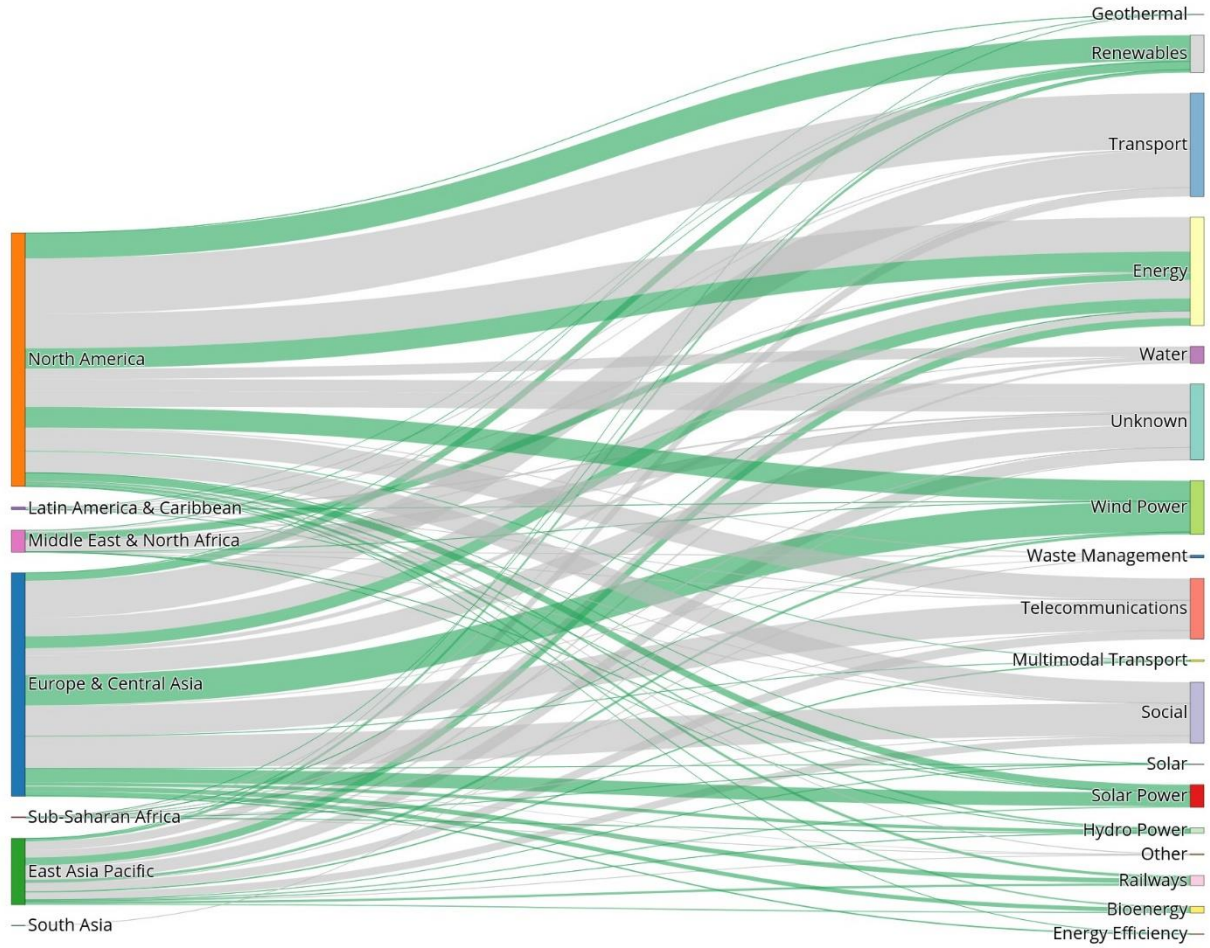


Note: Panel A captures overall, i.e., non-low-carbon and low-carbon, bilateral cross-border institutional infrastructure investment while panel B captures low-carbon bilateral cross-border institutional infrastructure investment.
Source: Authors based on Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.

Institutional infrastructure investments in low-carbon concentrate mostly in renewables, wind, and solar power as well as other green energy (Figure 4.6). Notably, investments from the Europe and Central Asia region dominate the solar and wind asset sectors, whereas North American investments are strong in the combined renewables asset sector and green energy. In the low-carbon category, East Asia and Pacific investments are strongest in railways, and Middle East and North African investments show much activity in low-carbon energy. Investments from the remaining regions are minor in low-carbon categories.

Figure 4.6. Bilateral institutional real economy infrastructure investment holdings by source region and destination sector

For the year 2020 across OECD and G20 sources and global destinations; low-carbon holdings shown in green



Source: Authors based on Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.

Figure 4.7 shows a detailed view of the investment instruments used by the four types of institutional investors, i.e., asset managers, pension funds, sovereign wealth funds and insurance companies, and how they are channelled to infrastructure investments. Investments into low-carbon (or attributed to low-carbon by share and association of instrument) are shown in green. Box 4.1 defines and provides an overview of financing instruments considered in this section.

Box 4.1. Overview of financing instruments considered in this section (segment 2).

There are different channels for investment in (low-carbon) infrastructure by institutional investors. Different types of financing instruments and investment funds vary with respect to the amount and type of assets they bundle, the liquidity and cash flows they provide, and the extent to which these instruments can be traded. The descriptive analysis of this section distinguishes among the following investment vehicles (see OECD (2020[17])and (2015[23]) for details):

- Direct **project equity** are shares that a developer or other investors hold, specifically in the project in questions. Direct **project debt** are credits or other forms of debt finance, specifically linked to the project in question.
- **Unlisted funds**[16] are funds that pool capital from multiple investors and hold assets other than traded assets, i.e., other than stocks or bonds. For the sake of this analysis, these assets would typically be infrastructure projects, such as wind power plants or toll bridges. In contrast, **listed funds** hold traded assets, i.e., stocks and bonds.
- **Exchange traded fund (ETF)** represents a fund that holds traded assets and which itself is traded. Most ETFs are following an index, i.e., are a common passive investment vehicle.

Additionally, this section considers securitised investment instruments:

- **Yield companies (YieldCos)** describes a publicly traded company that is formed to own operating, non-traded assets that produce cash flows. The cash is distributed to investors as dividends.
- **Real estate investment trusts (REITs)** refer to a corporation or trust that uses the pooled capital of many investors to purchase and manage income property or mortgage loans. REITs invest in real estate or loans secured by real estate and issue shares in such investments. A REIT is similar to a closed-end mutual fund.
- **Infrastructure investment trusts (INVITs)** are basically infrastructure-specific REITs; mostly used in India.
- A **Master Limited Partnership (MLP)** is a publicly traded limited partnership that includes one or more partners who have limited liability. This US-specific financial instrument can hold real estate and natural resource extraction projects. When viewed through the lens of infrastructure, this implies that MLPs can typically not be used for low-carbon infrastructure.

Source: (OECD, 2015[23]; 2020[17]).

Low-carbon infrastructure investments are unevenly distributed across investors and financing instruments. Among different types of institutional investors, pension funds represent the most important source of cross-border and low-carbon infrastructure investment low-carbon (46%) followed by asset managers (28%), insurance companies (22%) and sovereign wealth funds (5%) (Figure 4.7). Most low-carbon institutional infrastructure investments are financed through unlisted funds that go into investments of wind and solar power. Further investment instruments employed by institutional investors to finance low-carbon infrastructure are YieldCos, project equity and project debt.

When comparing overall cross-border infrastructure investment to low-carbon investment, the set of employed instruments differs. While project debt, project equity and unlisted funds remain important instruments, securitised products take on more nuanced roles. Master Limited Partnerships (MLPs) naturally vanish since they are by their legal definition meant for fossil fuel-related assets (and non-infrastructure assets). Real Estate Investment Trusts (REITs) equally disappear, as they are in practice mostly used for real estate and related structures like telecommunication buildings, i.e., may not seem

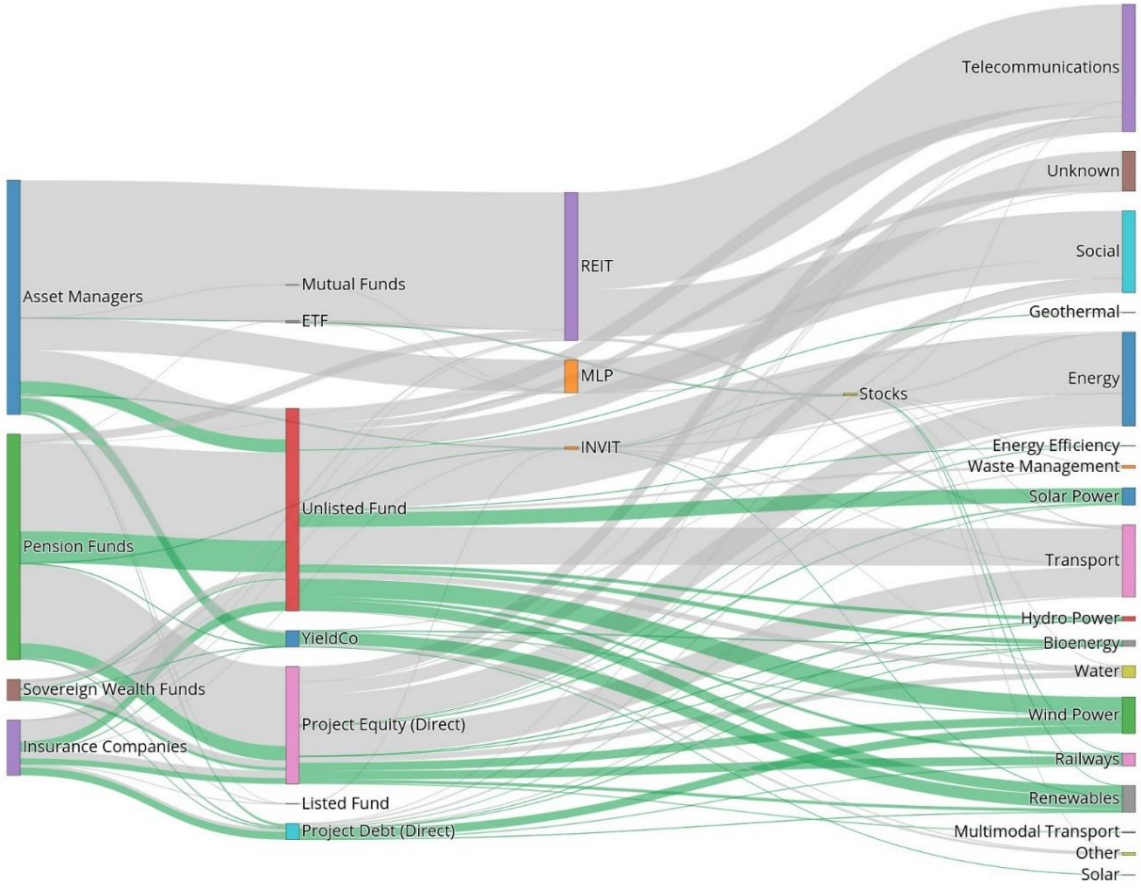
suitable for e.g., renewable energy investments. The remaining securitisation instruments are Infrastructure investment trust (INVITs) and YieldCos. INVITs are a relatively novel instrument specific to only a few countries (notably India), and therefore are small in magnitude. YieldCos, on the other hand, rival unlisted funds as most relevant instrument for the combined renewables sub-sector.[17]

Different investor preferences in terms of the liquidity of their investments and the varying flexibility of financing instruments determine the extent to which there is potential to shift capital from non-low-carbon to low-carbon infrastructure FDI. While asset owners, i.e., pension funds, insurance companies, and sovereign wealth funds demonstrate a preference for long-term capital appreciation and hold mostly illiquid assets such as unlisted funds or direct equity, asset managers demonstrate a preference for liquidity and hold mostly securitised products like YieldCos, REITs and INVITs (OECD (2020[17]) and Figure 4.7).

In summary, unlisted funds, direct project-level equity/debt and securitised products are important instruments to spur green infrastructure investments. Especially securitised products, e.g., YieldCos, INVITs and similar structures, can serve as a pathway to tap investors with a preference for liquid investment products for bundling, scaling up and selling low-carbon infrastructure investment. Aside from general preferences that asset managers show for liquid investments, securitisation could capitalise on trends towards, for example, defined contribution pension plans, i.e., retirement-focused long-term investing that still allows periodical re-allocations of investments. However, despite the potential for new securitised products, caution must be paid as there is no longer-term empirical evidence on the performance of products like YieldCos during a period of rising interest rates and the financial viability and attractiveness of securitised structures are, at their core, a function of the soundness of the underlying assets. Steady supply of quality projects is critical to scaling-up securitised vehicles. In this respect, investment, and infrastructure planning as well as infrastructure development policies are essential levers to shift and scale-up capital flows towards critical green infrastructure.

Figure 4.7. Institutional cross-border real economy infrastructure investment by investor and destination sector

For the year 2020 across OECD and G20 sources and global destinations; low-carbon shown in green



Note: See definitions of financial instruments and explanations on the abbreviations in Box 4.1.
Source: Authors based on Preqin (2020[33]) and IJGlobal (2019[34]) with some additions made based on Refinitiv (2022[31]) as well as primary research.

4.3. Segment 3: Cross-border listed stock investments in infrastructure

Figures in this section represent overall investment holdings of at least USD 2.2 trillion from global investors in stocks of OECD and G20 companies' infrastructure companies as of January 2022. A sizable share of almost USD 1 trillion of these USD 2.2 trillion are cross-border holdings, only USD 38 billion (4%) of these cross-border holdings can unambiguously be attributed to low-carbon infrastructure[18] (Figure 4.8). These low-carbon infrastructure holdings are mostly Renewable Independent Power Producers (Renewable IPPs), i.e., energy providers that fully operate based on low-carbon assets.

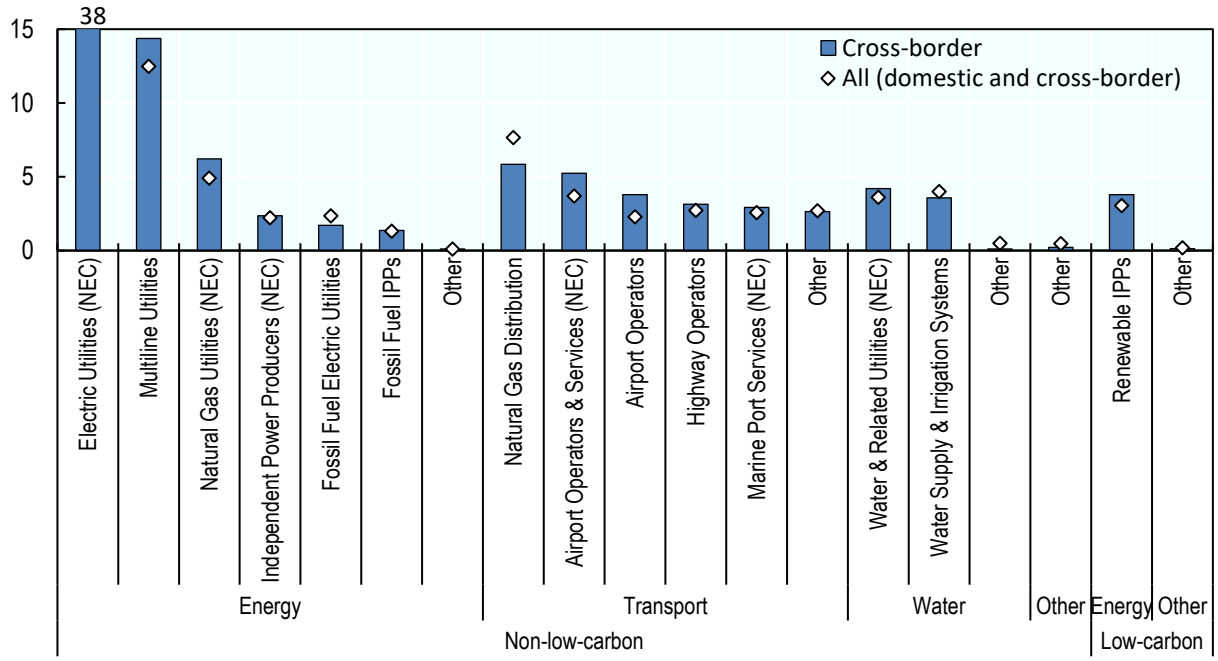
The scope of policy measures to scale-up infrastructure investment in this segment seems to be rather limited, since investment decisions in infrastructure in the form of listed stocks are rather indirect and investors have often only very intermediated influence on the composition of the physical assets owned by the companies held through these stocks. These investments may have in large part been driven by a

desire for financial exposure to certain sectors such as energy or transport rather than to infrastructure as such, let alone to low-carbon infrastructure in particular.

The sector composition of cross-border investments depicted in Figure 4.8 and all domestic and cross-border investments does not change tremendously. This pattern reflects the fact that corporate shares are a highly liquid asset and are therefore traded easily across borders. Only few barriers that may stand in the way of a direct investment also apply to investments in corporate shares so that country policy setups will make much less of a difference for investment decisions.

Figure 4.8. Stock holdings in infrastructure companies

January 2022 by global investors in OECD and G20 companies



Note: This chart shows all (domestic and cross-border) and cross-border stock holdings in infrastructure companies by global investors in OECD and G20 companies (as of January 2022). Data in this chart do not include telecommunications stocks. Infrastructure assets of less than 1% of the total are aggregated as "Other".
Source: Authors based on Refinitiv (2022[31]).

5 Conclusion and discussion

This paper shows the breadth, depth, distribution, and context of OECD and G20 low-carbon cross-border infrastructure investments. Although largely an empirical exercise in preparation for deeper policy analysis, the descriptive analysis itself provides insights into low-carbon cross-border investments which can serve as a starting point for a discussion of effective policy measures. Due to data availability, the analysis is based on three different data segments covering infrastructure investments into real economy assets by actors from the real economy (segment 1) and by actors from the financial economy (segment 2) as well as infrastructure investments into the financial economy by actors from the financial economy (segment 3).

Results show that infrastructure investment flows and holdings still concentrate in non-low-carbon infrastructure. Geographically, Europe and Central Asia as well as North America host the bulk of infrastructure investments in all types of real economy infrastructure assets. In contrast, developing and emerging markets host only a small proportion of global low-carbon infrastructure investments.

Investment decisions in general, and especially into low-carbon infrastructure, are not made purely on the merit of the involved technology and demand for infrastructure services but are dependent on policy measures as well. Descriptive results of this paper allow to draw tentative conclusions about channels that offer scope to increase cross-border infrastructure investments and to shift capital towards low-carbon infrastructure assets.

Considering investment holdings in low-carbon infrastructure by financial economy actors in the financial economy, i.e., holdings of listed stocks (segment 3), shows that cross-border transactions do not influence investment decisions much so that country policy setups will make much less of a difference for investment decisions. Investment decisions in the financial economy are more likely made based on exposure and portfolio considerations than environmental considerations and infrastructure investment in the financial economy do not have much of an immediate emissions impact. For this reason, it would be important to find ways to shift infrastructure investments, that currently flow into the financial economy, to the real economy through instruments which are equally attractive to financial economy investors as investments in listed stocks.

The analysis of institutional investment in real economy infrastructure (segment 2) suggests that there is scope for policy measures to scale up infrastructure investments in general while adjustments of regulations for financing instruments might also help shifting capital to low-carbon infrastructure projects. Pension funds and insurance companies only exploit 4% of investments in infrastructure that would be allowed under current regulatory limits thus indicating that regulations do not represent a severe barrier to infrastructure investments by institutional investors. However, incentivising the use of financing instruments, i.e., securitised products, that bundle projects and meet different tastes for liquidity of investors can help shifting capital into low-carbon infrastructure investment. While some instruments analysed in this paper have proven to be important investment financing vehicles in low-carbon infrastructure in the past, policy makers need to consider changing conditions such as rising interest rates and resulting changes in investment decisions when revising regulations for certain products. Ensuring adequate investment vehicles to invest in infrastructure projects is even more important for small and medium size pension funds and insurance companies.

Finally, it is important to highlight that pension funds and insurance companies should invest in infrastructure if a strong regulatory framework that ensures that their boards are independent from undue political influence, members of the board have the right fit and proper requirements so their members can make informed decision and have investment teams to advise in investment decision.

Patterns of cross-border infrastructure investments in low-carbon assets from and into the real economy (segment 1) highlight the importance of cross-border direct investments, i.e., greenfield FDI, in low-carbon assets. Results show that project-level infrastructure investments are more likely to be low-carbon than investments through mergers and acquisitions. This may reflect the tendency of low-carbon projects to be financed through project finance vehicles as opposed to fossil fuel-based activity being financed through corporate finance (OECD, 2016[36]; Steffen, 2018[37]). Further research would be needed to corroborate this finding and draw policy conclusions.

Future research, including as part of the OECD FDI Qualities Initiative, could investigate policies, barriers and enabling conditions for cross-border investments in low-carbon infrastructure assets based on the data presented in this study. Given the infrastructure financing gap, particularly in emerging and developing economies, an in-depth comparative study of investment incentives and barriers to greenfield FDI in low-carbon infrastructure in emerging and developing economies can shed light on enabling conditions, such as policy commitments to climate targets, and impediments for infrastructure FDI.

Annex A. Countries and regions covered

This Annex provides methodological details of the analytical concepts (section 2) and data (section 3) analysed in section 4. This Annex adds detail to the definitions of *low-carbon* as well as *infrastructure* to the outlines in section 2.1 before providing details on the curation, estimation and aggregation of data by investment segment.

All data efforts aim to include the following 49 source countries, which are the OECD member countries as of 2020 and G20 countries including all EU28 countries. Source countries were covered as comprehensively as databases allowed, aiming for global coverage. The below tables show countries and regions in detail, as used in the underlying datasets of segments 1 and 2, respectively.

Table A.1. Countries and regions in segment 1

By source/destination and region

	East Asia Pacific	Europe & Central Asia			Latin America & Caribbean		Middle East & North Africa	North America	South Asia	Sub-Saharan Africa		Other
Sources	AUS	AUT	FRA	MLT	ARG		ISR	CAN	IND	ZAF		
	CHN	BEL	GBR	NLD	BRA		SAU	USA				
	IDN	BGR	GRC	NOR	CHL							
	JPN	CHE	HRV	POL	COL							
	KOR	CYP	HUN	PRT	CRI							
	NZL	CZE	IRL	ROU	MEX							
		DEU	ISL	RUS								
		DNK	ITA	SVK								
		ESP	LTU	SVN								
		EST	LUX	SWE								
		FIN	LVA	TUR								
Destinations	AUS	ALB	GEO	NOR	ARG	HND	ARE	CAN	AFG	AGO	MRT	BMU
	BRN	ARM	GRC	POL	ATG	JAM	BHR	USA	BGD	BDI	MUS	CYM
	CHN	AUT	HRV	PRT	BHS	LCA	DZA		BTN	BEN	MWI	HKG
	FJI	AZE	HUN	ROU	BLZ	MEX	EGY		IND	BFA	NAM	HTI
	FSM	BEL	IRL	RUS	BOL	NIC	IRN		LKA	BWA	NER	MAC
	IDN	BGR	ISL	SRB	BRA	PAN	IRQ		MDV	CAF	NGA	MCO
	JPN	BIH	ITA	SVK	BRB	PER	ISR		NPL	CIV	RWA	PRK
	KHM	BLR	KAZ	SVN	CHL	PRY	JOR		PAK	CMR	SDN	STP
	KOR	CHE	KGZ	SWE	COL	SLV	KWT			COD	SEN	XKX
	LAO	CYP	LTU	TJK	CRI	SUR	LBN			CPV	SLE	
	MMR	CZE	LUX	TKM	CUB	TTO	LBY			DJI	SOM	
	MYS	DEU	LVA	TUR	DOM	URY	MAR			ETH	SSD	
	NZL	DNK	MDA	UKR	ECU	VEN	OMN			GAB	SWZ	
	PHL	ESP	MKD	UZB	GTM	DMA	PSE			GHA	SYC	
	PNG	EST	MLT	LIE	GUY	GRD	QAT			GIN	TCD	
	SGP	FIN	MNE	HKG			SAU			GMB	TGO	

	THA	FRA	MNG				TUN			GNB	TZA	
	TWN	GBR	NLD				YEM			GNQ	UGA	
	VNM									KEN	ZAF	
	WSM									LBR	ZMB	
										MDG	ZWE	
										MLI	COG	
										MOZ		

Source: Authors.

Table A.2. Countries and regions in segment 2

By source/destination and region

	East Asia Pacific	Europe & Central Asia		Latin America & Caribbean	Middle East & North Africa	North America	South Asia	Sub-Saharan Africa	Other
Sources	AUS	LUX	IRL	COL	SAU	USA	IND	ZAF	PRI
	CHN	GBR	ISL	MEX	ISR	CAN			
	JPN	SWE	BEL	BRA					
	KOR	FRA	ESP	CHL					
	NZL	CHE	AUT						
	IDN	FIN	PRT						
		DEU	EST						
		NOR	RUS						
		DNK	GRC						
		NLD	CZE						
		ITA							
Destinations	AUS	AUT	ITA	ARG	ARE	CAN	IND	BWA	ABW
	CHN	BEL	LTU	BOL	EGY	USA	PAK	CIV	PRI
	IDN	BGR	LUX	BRA	ISR			CMR	REU
	JPN	CHE	LVA	CHL	JOR			ETH	
	KHM	CZE	MLT	COL	MAR			GHA	
	KOR	DEU	NLD	CRI	SAU			KEN	
	LAO	DNK	NOR	DOM	TUN			MDG	
	MYS	ESP	POL	ECU				MLI	
	NZL	EST	PRT	GTM				MOZ	
	PHL	FIN	ROU	HND				MRT	
	SGP	FRA	RUS	JAM				MUS	
	THA	GBR	SRB	MEX				NGA	
	TWN	GRC	SVK	NIC				RWA	
	VNM	HRV	SVN	PAN				SEN	
		HUN	SWE	PER				TZA	
		IRL	TUR	SLV				UGA	
				TTO				ZAF	
								ZWE	

Source: Authors.

Annex B. Classification of assets, activities and sectors as low-carbon

Table B.3 shows details of what infrastructure categories were covered by or selected from the commercial databases for use in this report. Aside from the detailed sub-sectors included here, it also shows if the sub-sector of an investment is classified as low-carbon or not, and which sector aggregates which sub-sectors. Table A.3 lists infrastructure-relevant sectors and technologies that qualify under the narrowed definition outlined in Box 2.1 based on their same select sustainable finance taxonomies, green bond standards and/or guidelines (analysed resources) in select OECD and G20 jurisdictions. The analysis aimed to identify the lowest common denominator of these standards and guidelines to develop a working definition.

Table B.1. Sectors by segment and infrastructure category

Infrastructure category	Segment 1	Segment 2	Segment 3	Low-carbon
Energy	Biomass power Geothermal electric power Hydroelectric power Marine electric power Other electric power generation (Renewable Energy) Solar electric power Wind electric power	Bioenergy Energy Efficiency Geothermal Hydro Power Renewables Solar Solar Power Wind Power	Renewable IPPs	Yes
	Fossil fuel electric power Other electric power generation (Coal, oil and gas) Pipeline transportation of natural gas Nuclear electric power generation Pipeline transportation of crude oil	Energy Fossil Fuels Natural Ressources Infrastructure Nuclear T&D Utilities	Electric Utilities (NEC) Fossil Fuel Electric Utilities Multiline Utilities Natural Gas Utilities (NEC) Independent Power Producers (NEC) Fossil Fuel IPPs Nuclear Utilities Nuclear IPPs	No
Transport	Rail transportation Transit & ground passenger transportation	Multimodal Transport Railways	Railway Operators	Yes
	Air transportation Warehousing & storage Other (Transportation & Warehousing) Other pipeline transportation	Airports Freight Ports Roads Street Lighting	Natural Gas Distribution Highway Operators Airport Operators Airport Operators & Services (NEC) Marine Port Services (NEC) Port Operators Marine Cargo Handling Services Port Warehousing Services Highways & Rail Tracks (NEC)	No
Telecommunications				Yes
	Wired telecommunication carriers Wireless telecommunication	Internet Network		No

	carriers Satellite telecommunications Other telecommunications	Satellite Infrastructure Telecommunications Wireless Communication			
Water				Yes	
	Water, sewage & other systems	Sewage Treatment Sewage Utilities Water Distribution Water Treatment Water Utilities	Water Supply & Irrigation Systems Water & Related Utilities (NEC) Sewage Treatment Facilities	No	
Waste management				Yes	
	Waste management & remediation services	Waste Management		No	
Social				Yes	
	General medical & surgical hospitals Other (Healthcare) Psychiatric & speciality hospitals	Construction Construction (Multisector) Education Government Buildings Healthcare Law and Order Infrastructure Other Social Infrastructure		No	
Other/Unknown				Yes	
	Other Sub-sectors	Diversified NA Unknown	Heating & Air-Conditioning Supply Corporate Financial Services (NEC)	No	

Source: Based on the data sources described in section 2.3.

Annex C. Data cleaning strategies

Investment by and into the real economy

The following provides an overview over data treatment of foreign direct investment by corporates as well as mergers and acquisitions. Since the data for this has been aggregated from 2 separate databases, the fDi database (Financial Times, 2022[32]) as well as the Refinitiv Eikon Mergers and Acquisitions database (Refinitiv, 2022[31]), methodology and caveats are described below separately. The aggregation itself is straightforward since the databases by definition exclude each other's content. That means both can easily be aggregated to the same dimensions, e.g. to bilateral investment aggregates or country-sector aggregates. Sector definitions are aligned by mapping fDi sector classifications to TRBC activity classifications, as outlined in section 2 and described below here.

Aggregating these databases across observations is justified by the view that mergers and acquisitions are a form of FDI. Nevertheless, data treatment had to follow and unify the classifications of the separate databases and is explained in the following.

Investments captured in the fDi Markets database

Data shown in section 3 contains observations from the fDI Markets databased (Financial Times, 2022[32]), spanning years 2006 to 2021 (up to mid-December) and containing global foreign direct investments in 28 infrastructure sectors by actors from OECD and G20 countries. Time series representation in section 3 skips the years 2003-2005 due to lack of clarity with respect to comprehensiveness of data in these years.

Observations are aggregates reporting an aggregate investment value by source, destination, country, target sector and year. Sectors were re-classified as described in section 2 and shown in table A.3.

Any aggregate data used here consist of projects with reported values only and were downloaded in the form of either yearly country pairs or sector-country years. Therefore, figures in section 3 only show investments if values had been reported and omit both bilateral investment relations as well as investments from/into sectors if investment values were not available even when an investment activity existed. Estimations of missing values would require project-level information or other additional information on which to base estimations. While this information is available in principle, download restrictions of the commercial database are prohibitively restrictive to allow for the necessary data gathering of project level information. Future empirical analyses may be able to provide a more complete picture provided more granular data can be used.

Investments captured in the Refinitiv Mergers and Acquisitions database

Data shown in section 4 builds on 13053 investment-level observations from the Thomson-Reuters Mergers and Acquisitions database, spanning years 2003 to 2021 (up to mid-December) and containing global mergers and acquisitions in 33 infrastructure activities (i.e. sectors) by companies from OECD and G20 countries. For reasons of consistency with fDi Markets data, time series of section 3 skip the years 2003-2005 of these mergers and acquisitions data as well as a comparison to domestic mergers and acquisitions.

The observed mergers and acquisitions are aggregated to country-level, bilateral country-pair observations or country-sector observations for use in the figures of section 3. Since the data already adhered to TRBC definitions, no reassignment of sector or activity classifications was necessary and classification of low-carbon or not low-carbon activities could be mapped straightforwardly (see Table A.3).

Note that sector classifications did not allow disaggregating some sectors to a level of granularity which would have made low-carbon investments visible. This is in particular the case for the *Electric Utilities (NEC)* category, which could hide mergers and acquisitions targeting utilities with lots of low-carbon assets in their portfolio.

Institutional investment in the real economy and overall investments into the financial economy

Data for institutional investment is straightforwardly taken from the data exercise of (OECD, 2020[17]), with added granularity on country-level investments. The following will give a summary of the exercise of OECD (2020[17]) and an additional explanation of changes diverging from the OECD (2020[17]) data that were necessary for the data analysis done here.

Institutional investment data used in section 3 is based on commercial data and supplemented by primary data collection and econometric techniques to fill gaps. The main databases used for data gathering are Eikon (Refinitiv, 2022[31]), Preqin (2020[33]) and IJGlobal (2019[34]). The aggregation avoids double-counting and other overlaps by collecting data at a disaggregated level, at which distinctions are easily made, and then aggregating to the level presented here.

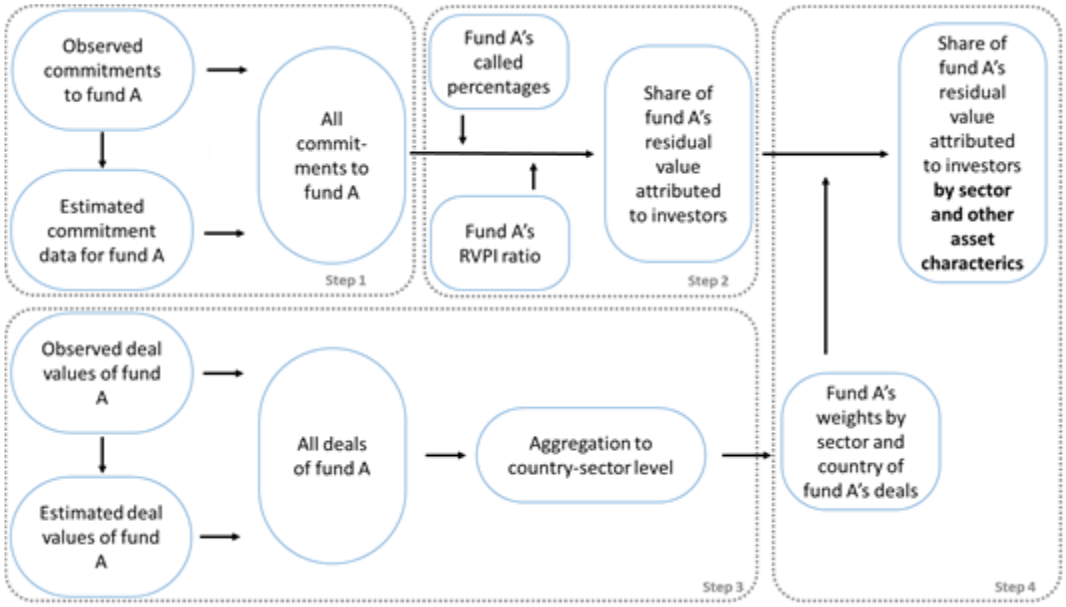
Commercial data on institutional investment data suffers from quality and availability gaps. To develop a composite view of global infrastructure investments, this report employs statistical techniques to estimate investment values where gaps exist and existing data allows estimation. Since the nature of data gaps differs between, sometimes even within databases, estimation methods differ as well.

Generally, unobserved values are replaced through prediction-based approaches. When prediction is infeasible or does not lead to robust results, estimations rely on averaging over peer-groups of the observations in question. The following sections provide details on the prediction, averaging and aggregation methods employed and discusses how investment values are attributed to investors and sectors.

For investments made through unlisted funds, the estimated and observed data is used to construct an attribution of investments to investors, as shown in Figure A.1. Note that investors in a fund are not the owners on record of the invested assets and the returns for a fund's investor are based on the portfolio of the fund's underlying assets. In preparation for estimations, all past owners are excluded. This is to ensure that the aggregated results only reflect current investment.

Although individual deals cannot directly be attributed to the investors of a fund, investments of a fund can be attributed to investors of that fund according to how much the single investors committed to the funds in question.

Figure C.1. Estimation and attribution process for unlisted funds data



Note: Investment through funds captured in the IJGlobal (2019[34]) database is added separately based on deal value only.
Source: Authors

In cases where a prediction of commitments is not possible due to missing data, the missing commitment values are replaced by averaged commitment values. Averages are calculated on the closest peer-group of observed commitments, and if data is missing, averages are calculated based on a less directly comparable peer-group. The closest peer group for calculated commitment averages is a group of commitments with the same industry, strategy, country and inception year of the fund. These categories are gradually relaxed to less comparable peer-groups if missing data could not be filled in.

Direct project-level investments

Data on direct project-level investments by institutional investors is sourced from IJGlobal (2019[34]), Preqin (2020[33]) and (Röttgers, Tandon and Kaminker, 2018[21]).This information on direct investment is merged to arrive at the overall direct investments by institutional investors, using manual merging and OpenRefine to avoid double-counting of investments. As in the case of unlisted funds, careful attention is paid to exclude past owners of assets.

The merged data provides information on 953 observed transactions with equity participation by an institutional investor. Due to missing values, equity investment are estimated for a portion of these transaction. To estimate the unobserved equity value, first a regression is run using information about investors and asset[19]. Next, gearing ratios[20] are applied to arrive at equity portions of deals, and percentage stakes acquired by investors are applied to arrive at the absolute value of direct institutional equity investment.

The merged data also provides information on 168 observed transactions involving debt provision by an institutional investor. Of these, 4% of the unobserved debt investment values are straightforwardly calculated based on observed information. For the remaining data gaps of 79% of the investments, values are estimated. An in-sample comparison reveals that the average of total observed debt investment share for a deal is a good approximation of the observed USD debt shares. Consequently 18% of the remaining missing values are replaced based on these averages. Missing data for the remaining 61% of observed deals are replaced by averages of investments in a peer-group based on asset, deal and investor

characteristics, assuming representativeness of these groups. One final observed debt investment is dropped since no useful data for estimation was observed for this investment.

Listed funds and listed stocks

Investment data for publicly listed infrastructure stocks is retrieved from Thomson-Reuters Eikon (Refinitiv, 2022[31]).

For listed stocks of corporations, the Eikon data provides a list of investors and the percentage shares of investments in these companies in USD. These shares are then multiplied by the market capitalisation. These values combined with the investor information provide the investor-company-level information on investments, including the investment value. Further, Eikon provides a sector-classification, as presented in Table A.3 (there for segment 3 only; data entering segment 2, e.g. INVITs and YieldCos, see OECD (2020[17])).

For listed infrastructure funds the analysis starts by filtering all funds tagged as infrastructure in the Lipper funds database of Eikon. The available funds include listed mutual funds, INVITs and ETFs. Out of these 2000 funds, useful data exists for only 148 funds. The analysis is based on these 148 funds only since no useful information on the other funds is available to estimate their size as well as holdings or ownership composition. Fund holdings typically are equity shares (e.g. stocks), fixed income instruments (e.g. bonds) and cash. Rather than include all investments by these funds as infrastructure, the analysis includes only those fund holdings matching the infrastructure definition outlined in chapter 2 of OECD (2020[17]) (see discussion in Box 2.1 there). Data on YieldCos and REITs has been treated similarly. Where possible, desk research is used to supplement Eikon data to increase comprehensiveness for the instruments. This is especially true for INVITs where most of the data is collected through desk research.

Note that overlap is avoided between institutional investor holdings through listed funds and direct institutional investor holdings in corporations. Since the direct holdings do not include holdings of listed fund shares, the funds' holdings are only included through the listed fund holdings. So while an institutional investor may hold shares of a corporation directly as well as through listed infrastructure funds, these are cumulative holdings rather than double-counted.

For all listed items, observed ownership and holdings are noticeably incomplete as they do not add up to 100% of shares. As is the nature of publicly traded data, information on details is largely available, but not always complete. This would indicate that the aggregates presented in section 3.2 and 3.3 are only a lower bound. However, typically data for large transactions and for large investors is systematically better tracked than for small investors or transactions. The analysis can reasonably assume that investments of these investors are in included in aggregates of section 3, and should provide a useful if not even representative indication of the actual shares of infrastructure holdings of listed infrastructure stocks. For listed funds the same applies, with the exception of funds without data, for which the analysis has to stay agnostic.

Note that data on listed stocks excludes the all telecommunication stocks. For the typical institutional investor, investments into telecommunication infrastructure in the real economy represents an infrastructure investment as much as any other infrastructure investment, i.e. it covers their long-term liabilities with stable cash flow. This is why this type of investment is included in segment 2. In equity markets, however, long-term liabilities is not necessarily what drives investments across investors, and telecommunications of the categories involved, due to the underlying market that represents exposure to a fast-changing technology sector more than to infrastructure, may here not been seen as long-term infrastructure investment. Therefore, and since telecommunication is the only super-category here that has clearly only very little relation to the environment, it is excluded in segment 3. Since it is not low-carbon infrastructure, it stands to reason that including it would not have changed the picture, other than obscuring the already partly hidden and otherwise small low-carbon share.

Additional data treatment

For the country-level analysis here, some data additionally was attributed to countries, while in OECD (2020[17]) it was only aggregated to a regional level or not included in aggregations with a geographical dimension at all. This in particular applies to the unlisted funds data from Preqin (2020[33]) as well as REIT, MLP and YieldCo data from Eikon (Refinitiv, 2022[31]).

While for unlisted funds much country-level information is available through the information on the location of the physical asset, the estimated fund values had to be distributed among target countries. This distribution, in line with how other distributions were made in OECD (2020[17]) was done pro-rata among all countries with any value in the observed year based on the observed, estimated and already through estimation attributed investments.

For MLPs, YieldCos and REITs, the locations of the physical assets were not straightforwardly available from the commercial data. Instead, each category was treated separately. For MLPs, the relevant legal structure is only available in the United States, and hence all asset countries were set to *United States*. For YieldCos and REITs, the data relies on an approximation. Looking into all YieldCos and REITs covered by the database reveals that nearly all of them hold a majority of their assets in the home country of the instrument. While not strictly accurate, and easily improved given the time to filter asset locations from annual reports, this is a close approximation of the geographical impact of investments into these instruments.

References

African Development Bank (2018), *African Economic Outlook 2018*, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf (accessed on 6 April 2022). [11]

Asian Development Bank (2017), *MEETING ASIA'S INFRASTRUCTURE NEEDS*, Asian Development Bank, Manila, https://www.adb.org/sites/default/files/publication/227496/special-report-infrastructure.pdf (accessed on 29 April 2020). [10]

Della Croce, R. (2014), *I.6. ARE INSTITUTIONAL INVESTORS THE ANSWER FOR LONG-TERM DEVELOPMENT FINANCING?*, OECD Publishing , Paris, https://doi.org/10.1787/888933121601. [20]

Della Croce, R. (2011), "Pension Funds Investment in Infrastructure: Policy Actions", *OECD Working Papers on Finance, Insurance and Private Pensions*, No. 13, OECD Publishing, Paris, https://doi.org/10.1787/5kg272f9bnmx-en. [22]

Della Croce, R. and J. Yermo (2013), "Institutional Investors and Infrastructure Financing", *OECD Working Papers on Finance, Insurance and Private Pensions*, No. 36, OECD Publishing, Paris, https://doi.org/10.1787/5k3wh99xgc33-en. [26]

Financial Times (2022), *fDi Markets*, https://www.fdimarkets.com/ (accessed on 5 April 2022). [32]

G20/OECD (2019), *ANNUAL SURVEY OF LARGE PENSION FUNDS AND PUBLIC PENSION RESERVE FUNDS REPORT ON PENSION FUNDS' LONG-TERM INVESTMENTS*, http://www.oecd.org/finance/survey-large-pension-funds.htm (accessed on 20 July 2020). [40]

G20/OECD (2013), *High-level principles of long-term investment financing by institutional investors*, http://www.oecd.org (accessed on 18 June 2020). [30]

GFANZ (2022), *Glasgow Financial Alliance for Net Zero*, https://www.gfanzero.com/ (accessed on 4 April 2022). [6]

Heinkel, R., A. Kraus and J. Zechner (2001), "The Effect of Green Investment on Corporate Behavior", *The Journal of Financial and Quantitative Analysis*, Vol. 36/4, p. 431, https://doi.org/10.2307/2676219. [19]

Hepburn, C. et al. (2020), "Committed Emissions from Existing and Planned Power Plants and Asset Stranding Required to Meet the Paris Agreement", https://econpapers.repec.org/RePEc:idb:brikps:8886 (accessed on 17 July 2020). [3]

IJGlobal (2019), *IJ Global Infrastructure Transactions Database*. [34]

Inderst, G. (2016), "Infrastructure Investment, Private Finance, and Institutional Investors: Asia from a Global Perspective", *SSRN Electronic Journal*, https://doi.org/10.2139/ssrn.2721577. [24]

Inderst, G. (2016), "Infrastructure Investment, Private Finance, and Institutional Investors: Asia from a Global Perspective", *SSRN Electronic Journal*, https://doi.org/10.2139/ssrn.2721577. [28]

Jachnik, R., M. Mirabile and A. Dobrinevski (2019), "Tracking finance flows towards assessing their consistency with climate objectives", *OECD Environment Working Papers*, No. 146, OECD Publishing, Paris, https://doi.org/10.1787/82cc3a4c-en. [18]

Kaminker, C. (2016), "Progress Report on Approaches to Mobilising Institutional Investment for Green Infrastructure", OECD, Paris. [29]

Koks, E. et al. (2019), "A global multi-hazard risk analysis of road and railway infrastructure assets", https://doi.org/10.1038/s41467-019-10442-3. [38]

NCE (2016), *THE SUSTAINABLE INFRASTRUCTURE IMPERATIVE Financing for Better Growth and Development THE 2016 NEW CLIMATE ECONOMY REPORT*, New Climate Economy, http://www.newclimateeconomy.report (accessed on 29 April 2020). [9]

Nelson, D. and B. Pierpont (2013), "The Challenge of Institutional Investment in Renewable Energy CPI Report Climate Policy Initiative". [25]

Nicolas, C. et al. (2019), *STRONGER POWER Improving Power Sector Resilience to Natural Hazards LIFELINES: The Resilient Infrastructure Opportunity*, http://www.worldbank.org (accessed on 29 April 2020). [39]

OECD (2023), *Developing an investment policy framework for climate adaptation: A scoping note*, DAF/INV/WD(2023)8. [43]

OECD (2023), *Improving the Landscape for Sustainable Infrastructure Financing*, OECD, Paris. [15]

OECD (2023), *Pension Markets in Focus Preliminary 2022 Data - June 2023*, OECD, Paris, https://www.oecd.org/finance/private-pensions/globalpensionstatistics.htm (accessed on 7 August 2023). [35]

OECD (2022), *FDI Qualities Policy Toolkit*, OECD Publishing, Paris, https://doi.org/10.1787/7ba74100-en. [13]

OECD (2021), *Defining infrastructure*, OECD Working Party on National Accounts, SDD/CSSP/WPNA(2021)1/REV1. [16]

OECD (2020), *Green Infrastructure in the Decade for Delivery: Assessing Institutional Investment*, Green Finance and Investment, OECD Publishing, Paris, https://doi.org/10.1787/f51f9256-en. [17]

OECD (2016), "Fragmentation in clean energy investment and financing", in *OECD Business and Finance Outlook 2016*, OECD Publishing, Paris, https://doi.org/10.1787/9789264257573-10-en. [36]

OECD (2015), *Mapping Channels to Mobilise Institutional Investment in Sustainable Energy*, Green Finance and Investment, OECD Publishing, Paris, https://doi.org/10.1787/9789264224582-en. [23]

OECD (2002), *OECD Glossary of Statistical Terms - Infrastructure Definition*, https://stats.oecd.org/glossary/detail.asp?ID=4511#:~:text=OECD%20Statistics,utility%20lines%20and%20public%20buildings. (accessed on 4 April 2022). [42]

OECD (forthcoming), *FDI Qualities Policy Toolkit*, OECD Publishing. [41]

OECD/The World Bank/UN Environment (2018), *Financing Climate Futures: Rethinking Infrastructure*, OECD Publishing, Paris, https://doi.org/10.1787/9789264308114-en. [7]

Preqin (2020), *Alternative Assets Data, Solutions and Insights*. [33]

Rainforest Action Network (2021), *Banking on Climate Chaos 2021*, https://www.bankingonclimatechaos.org/bankingonclimatechaos2021/. [14]

Refinitiv (2022), *Eikon*, https://www.refinitiv.com/en/products/eikon-trading-software. [31]

Röttgers, D., A. Tandon and C. Kaminker (2018), "OECD Progress Update on Approaches to Mobilising Institutional Investment for Sustainable Infrastructure", *OECD Environment Working Papers*, No. 138, OECD Publishing, Paris, https://doi.org/10.1787/45426991-en. [21]

Smith, C. et al. (2019), "Current fossil fuel infrastructure does not yet commit us to 1.5 C warming", *Nature*, https://www.nature.com/articles/s41467-018-07999-w?fbclid=IwAR06X-jgZT5jRddBiLf2j_n4LjexWpJ1viWm2UuO5SiHQzI63vVouozvexE (accessed on 17 July 2020). [4]

Steffen, B. (2018), "The importance of project finance for renewable energy projects", *Energy Economics*, Vol. 69, pp. 280-294, https://doi.org/10.1016/j.eneco.2017.11.006. [37]

TCFD (2022), *Task Force on Climate-Related Financial Disclosures*, https://www.fsb-tcfd.org/ (accessed on 4 April 2022). [5]

UN (2018), *The World's Cities in 2018- Data Booklet*, United Nations, Department of Economic and Social Affairs, Population Division, https://www.un.org/en/events/citiesday/assets/pdf/the_worlds_cities_in_2018_data_booklet.pdf (accessed on 30 April 2020). [12]

UNOPS (2021), *Infrastructure for climate action*, https://content.unops.org/publications/Infrastructure-for-climate-action_EN.pdf?mtime=20211008124956&focal=none (accessed on 4 April 2022). [2]

World Bank (2019), *Who sponsors infrastructure projects? Disentangling public and private contributions 2017*, https://ppi.worldbank.org/content/dam/PPI/documents/SPIReport_2017_small_interactive.pdf (accessed on 8 August 2023). [8]

World Economic Forum (2020), *The Global Risks Report 2020*, https://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf. [1]

Youngman, R. and C. Kaminker (2016), "Institutional investors and green infrastructure investment: OECD report for the climate finance ministerial meeting", *OECD Climate Finance Ministerial*. [27]

Notes

[1] While this paper focuses on low-carbon infrastructure, scaling up investment and infrastructure for climate adaptation and resilience requires equally important attention ((OECD, 2023[43]).

[2] Note that among others, industrial plants such as steel mills and most types of real estate are beyond the scope of this analysis.

[3] A set of 45 Asian countries as listed in appendix 4.4 in ADB (2017[3]), excluding Japan, but including the OECD and G20 countries China, India, Indonesia and Korea.

[4] Although the consideration of real estate, such as commercial and residential buildings, is beyond this definition of infrastructure and represents a separate asset class. Real Estate Investment Trusts (REITs) with infrastructure assets in their underlying portfolio (i.e., REITs that hold only infrastructure and no real estate) are included in the empirical mapping undertaken for this report. They are infrastructure investment trusts in all but name, and therefore need to be considered as part of infrastructure analysis.

[5] Technically, the definition applied by the OECD (2020[17]) used to distinguish environmentally friendly aimed further than low-carbon, but certainly included all low-carbon infrastructure. Consequently, the definition of low-carbon used in this paper uses the same list and removes those categories that are clearly labelled as green for reasons other than their emissions impact.

[6] Importantly, sectors that are not included in Table 2.1 are not necessarily polluting industries but do not qualify as actively reducing carbon emissions of the economy.

[7] For the purposes of this analysis, the investments are considered institutional investments if they are made by the institutional investor types *pension fund*, *insurance company*, *sovereign wealth fund* (excluding strategic investment funds) and *asset managers*. Strategic Investment Funds (SIFs), endowment funds, family offices or so-called ultra-high-net-worth individuals are not included due to lack of data.

[8] Note that all data was downloaded before February 2022, and that data on listed infrastructure investments by institutional investors was downloaded in late February 2020 and therefore before the COVID-19 crisis fully hit the stock markets. Data on institutional investment was not updated to post-COVID-19 for two reasons. First, an update of listed data would inevitably have happened during rather than after the crisis, i.e., it would be influenced by the crisis, but at the time of writing it would not have been possible to say to what extent. Second, as other data, e.g., unlisted funds data, is updated only periodically, an update of only the listed investment data would have been inconsistent.

[9] However, it should be noted that the analysis of greenfield FDI includes announced and opened projects. Considering that announced projects may not materialise in real investments, the described lower bound of investments maybe challenged.

[10] While undisclosed bond ownership indeed curtails empirical research in institutional real economy investment patterns, there is no reason to think that the analysis misses a large part of the picture. Based

on discussions with experts and practitioners, the authors find that green bonds and other labelled fixed-income products have to date not delivered significant financing for infrastructure projects.

[11] Note that some of the underlying reported values are estimated values and it includes both announced and opened projects.

[12] Note that as pointed out in Annex C, for a large number of mergers and acquisitions no value was reported.

[13] Since it was not possible to collect the domestic equivalent for these data, a comparison with domestic values is not possible.

[14] It is worth noting though that not all other investment is in carbon-heavy activities. While a large part of the investments not classified as low-carbon indeed are in fossil fuel-based power assets and corporates (here aggregated within the "other energy" category), much of the investments are also in telecommunications, an infrastructure sub-sector with a low emissions impact.

[15] While this representation of institutional investment fills data gaps with estimation and can therefore be taken as largely comprehensive, it is noteworthy that numbers presented in this subsection are not an exact representation of OECD (2020[17]) since it excludes some negligible debt instrument categories.

[16]Funds are typically structured as limited partnerships with an asset/fund manager (party raising capital) as the general partner and investors (including institutional investors) in the fund as limited partners. Funds have a fixed lifespan which may be extend by the consent of limited partners. During the investment period, limited partners are entitled to cash flow which may either be distributed or reinvested. Distributions are typically paid on a pro rata basis. See OECD (2020[17]) for further details.

[17] This position of the only 19 YieldCos included in the underlying dataset of Figure 4.7 would be even more pronounced if all assets could be traced to their asset country rather than having to attribute the headquarter country of the YieldCo instead.

[18] Further granularity of the data would allow to track to what extent assets held by electric and multiline utilities can be classified as low-carbon and would thus add to low-carbon cross-border holdings.

[19] Information included in the regression underlying the prediction are country of origin of the investor, the investor type as well as the country, year and industry of the investment.

[20] Note that data gaps for gearing ratios and acquired stakes are filled using averaging of the observed values by peer-groups. Similar to the averaging procedure for missing values estimated for private equity data, the peer-group categories are gradually relaxed if there is no relevant peer-group over which to average.