

# Investment Trends and Outcomes in the Global Carbon-Credit Market

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# Executive summary

## Capital raised / committed

- **USD 18bn** of capital has been raised or committed to invest in carbon-credit funds over the last two and half years (Jan 2021 - June 2023). A further **USD 3bn** has already been committed over 2024 and 2025. Over 80% of this capital (**USD 15bn**) has been, and is intended, for nature-based projects (afforestation / reforestation, reducing emissions from deforestation, and improved forest management).
- One third of these financial commitments (**USD 5bn** since 2021) have been made by corporates, investing alongside project developers to secure long-term access to carbon credits. These corporates include some of the world's largest companies.

## Capital invested in projects

- Over the last three years nearly the same amount of capital was invested in carbon projects as was raised / committed (**USD 17bn**). Of this, **USD 7.5bn** was invested in the last year. In total some **USD 36bn** has been invested in carbon-credit projects from 2012 to 2022.
- Just under half (42%) of the USD 36bn has been devoted to nature-based projects. This share increased to 50% in the last three years, amounting to almost **USD 9bn**.
- The largest share of carbon project investment is in the East Asia and Pacific region (36%), followed by South Asia and Sub-Saharan Africa. North America is by far the largest destination for carbon-credit investment in rich countries.
- Investment levels over the past three years are running at **five times** the value of the global carbon-credit market (USD 1.5bn primary value). This is indicative of an industry planning for significant future growth.

## Future capital needs

- The current run rate of investment in carbon-credit projects is a **third** of the level needed to deliver the volume of credits required by 2030 under a 1.5C scenario. A further **USD 90bn** of capital is likely to be needed by 2030 to achieve the volume of credits required under this scenario. Around half of this capital would be for new projects and half to build out projects already in the pipeline.
- Under more conservative assumptions of demand growth, investment of between **USD 10bn** and **USD 40bn** is likely to be required by 2030. Nearly all of this capital would be needed to build out projects already in the registry pipelines.
- By 2050, cumulative capital expenditure of **USD 1,600bn** would be needed in carbon credits to achieve a 1.5C pathway. This is equivalent to an investment of **USD 60bn** per year.

## Climate outcomes and benefits

- Since 2020 over **1,500** new carbon-credit projects have been developed and registered with the five main registries. This is equivalent to around 520 new projects a year. The rate of new project registrations in the last three years is 160% of the rate from 2012 to 2020. The new projects added since the start of 2020 claim to save an additional **300MtCO<sub>2</sub>e/yr** of carbon emissions – around the same as the annual carbon emissions of the UK.
- In the last three years, a further **1,500** projects have been added to the development pipeline, representing another **530Mt/yr** of maximum potential emission reductions.
- As of July 2023, the 246 registered nature-based projects across the world now cover an area of around **30mn ha**. This is an area equivalent to the size of Italy, Poland or Ecuador. Three quarters of this area is devoted to REDD+ projects to protect forests, most of which are in tropical countries. A further **80mn ha** are currently under development as carbon projects – an area the size of Turkey or Mozambique.

# 1. Introduction and methodology

### Context

Projects that generate carbon credits for the voluntary carbon market have come under increasing scrutiny in recent years. These criticisms are often directed at older projects created under outdated standards or more relaxed approaches to verification. This criticism has helped accelerate action to improve standards, for example with the creation of the Integrity Council on the Voluntary Carbon Market (ICVCM).

However, this excessive attention on quality also risks deterring corporates from engaging in the voluntary carbon-credit sector all together. This in turn risks undermining corporate climate action.

A new wave of projects is being developed today that are being created under this new spotlight. Standards have improved and continue to evolve. Ratings firms and NGOs have also created systems to differentiate between the quality of projects. This is helping corporates to become aware of the quality of the credits they are buying. These new projects – many of which are nature-based – expected to deliver significantly improved climate outcomes and broader environmental and social benefits.

It is important for the continued success of the carbon-credit sector in supporting corporate climate action that the scale of these benefits is understood. Specifically, investment activity in developing carbon-credit projects is an important indicator of the availability of new projects that can support greater levels of corporate climate action.

### This report

This report presents results from our analysis of capital flows in the voluntary carbon market. The analysis looks at both capital raised/committed at the fund level, and capital invested directly in carbon-credit projects. Over the long term these two approaches should be roughly equal, but in the short term, project-level investment can lag capital raising as it can take several years to deploy funds.

The analysis focusses on investments made between 2012 and 2020, and 2020 to 2023. 2020 was a pivotal year for corporate climate commitments and interest in the carbon-credit market. It was the first five-year anniversary of the Paris Agreement and created a surge in interest in the private sector's role in tackling climate change.

Data has been obtained from three main sources: (i) a survey of market participants conducted during April and May 2023, (ii) analysis of over 400 public announcements of capital raises for low carbon funds, and (iii) modelled investment for over 7,000 projects, both registered and on the development pipeline.

This report also highlights the benefits of these new projects, in terms of new projects being started and their effect on carbon emissions.

### Acknowledgements

We are grateful to all the organizations that responded to the survey, as well as the generous support provided by three organizations to help fund the work: IETA, Verra and Sylvera. We also acknowledge the kind support from BioCarbon, EcoRegistry, Gold Standard, Thallo, Will Solutions Inc. and Xilva Global who assisted with the survey.

### Defining carbon-credit projects and funds

The purpose of this study is to identify and quantify capital flows for projects that generate carbon credits. These projects are a subset of all possible activities that could reduce or sequester carbon emissions. This is a potentially huge universe of projects. In 2022, for example, USD 1.3tn was invested in all energy-transition technologies, of which USD 0.5tn was in renewable-energy projects.<sup>(1)</sup>

Projects relevant for this analysis are those that are eligible for creating carbon credits, as defined by standard setting bodies such as Verra, Gold Standard, American Carbon Registry (ACR), Climate Action Reserve (CAR) and Puro Earth. These standards exclude many technologies that would be implemented without the need for carbon credits. These could include, for example, a wide range of energy efficiency or renewable technologies that are either cost effective in their own right or required under legislation.

When modelling capital investment in projects on the registries, identifying which projects to include is straight-forward as the projects are already selected. This study has also reviewed hundreds of announcements for capital raised in funds, both privately through the survey, and backed by public statements. Categorizing these funds is more problematic, as capital is often raised for multiple purposes, only part of which may be devoted to carbon credits. For example, funds may invest in general clean technologies or forest assets, which may or may not generate carbon credits at some point in the future. To be included in this assessment, *the creation of carbon credits should be the stated primary purpose of the fund or activity.*

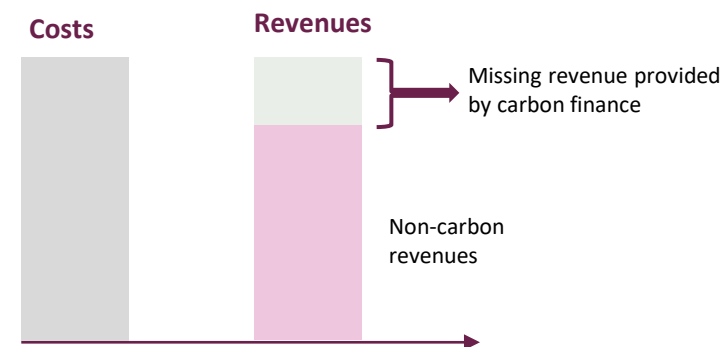
This definition excludes many funds. From an initial selection of some 400 funds, we identified 242 that could generate carbon credits and of these capital data was available for around 100 funds.

1. Source: IRENA, 2023, *Global landscape of renewable energy finance 2023*

Through the analysis, care was taken to avoid double-counting financial commitments. For example, corporates can commit finance to providing off-takes for carbon credits, but the developers also raise capital to invest in the projects that generate the credits.

### Quantifying carbon-credit investment

The figures presented in this report are intended to capture the incremental finance needed to make carbon projects viable, and hence create and sell carbon credits. We exclude capital requirements that would be covered by other forms of revenue, such as sales of products or government grants. This is illustrated in the figure below.



Modelled investment figures include all capital expenses required prior to project operation and first credit issuance. This includes feasibility assessments, development activities and project construction and the first two years of operation.

## 1.3 Data sources

Three research activities were brought together for this study:

### (i) Industry survey

A survey was sent to a range of market stakeholders active in investing in the carbon market in May 2023, including project developers, financial services companies and corporates. The questionnaire was also made available on Trove's website. Around 30 responses were received. Data from survey responses were combined with public announcements (ii).

### (ii) Review of public announcements of capital raised (up to end of June 2023)

Trove conducted independent analysis of public announcements of capital raised in the carbon-credit sector. The search was mainly focused on 2021 and later and includes collection up to the end of June 2023. The work resulted in a database of over 400 news announcements. These were categorized and assessed for relevance for inclusion in the voluntary carbon markets. Care was taken to avoid double counting across announcements and investments.

### (iii) Modelled capital investment

Data from the registries gives a picture of all projects which have been registered, or in the pipeline, for the purposes of generating voluntary carbon credits. Trove has developed a market-wide capital expenditure model based on our project-level cost models (see table on the right).

These breakdown capital costs into development-related expenditure (devex), feasibility-related expenditure (feasex) and capex (expressed per tonne of credit generated) for each project type. These capital costs are assigned to a particular year (or years) based on the date when projects were listed or registered. Data from five registries were analyzed: ACR (American Carbon Registry), CAR (Climate Action Reserve), Gold Standard, Puro Earth and Verra.

Project cost ranges <sup>(1)</sup>

Project type	Project subtype	Total costs (USD /tCO <sub>2</sub> e)
Carbon Engineering	Carbon Capture and Storage	50 to 130
	Biochar	10 to 60
Energy Efficiency	Clean Cooking	3 to 15
Nature Restoration	Afforestation/reforestation/revegetation	5 to 30
	Agricultural Land Management	10 to 70
	Avoided Conversion of Grasslands and Shrublands	4 to 40
	Mangroves	10 to 45
	Peatlands	5 to 25
	Seagrass Meadows	100 to 500
	Improved Forest Management	5 to 20
Non-CO2 Gases	Landfill Gas	1 to 20
	Waste Management	0 to 15
	Fugitive Emissions	0 to 20
REDD+	Various	10 to 20
Renewable Energy	Various	1 to 20

1. Source: Trove Research cost models as of September 2023. Capital cost coefficients are derived from the above total unit costs. Trove's cost models are disaggregated by project type and location and are validated with project developers.

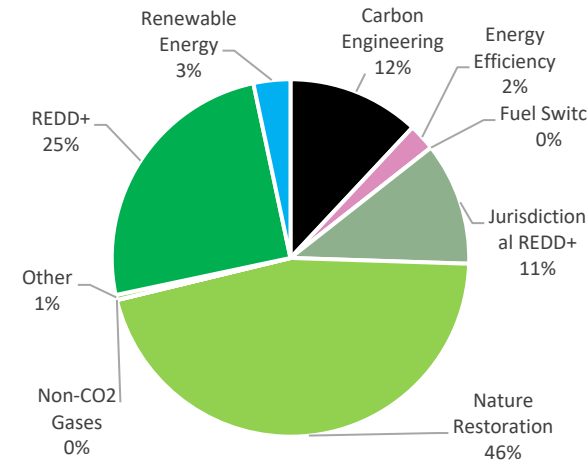
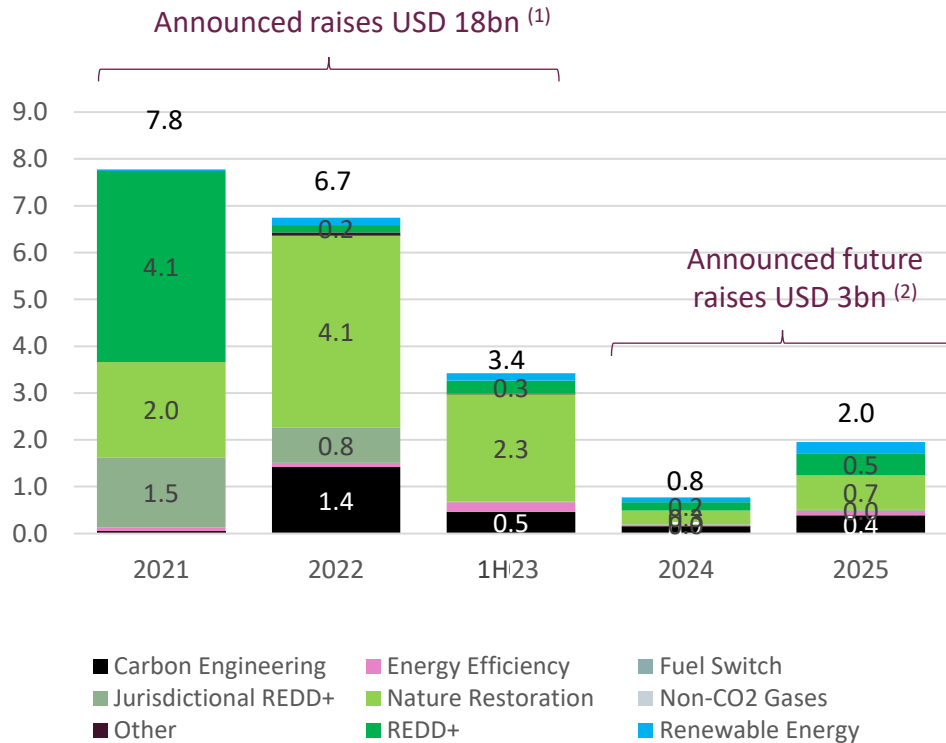
## 2. Capital investment trends

## 2.1 Announced capital raised and committed

## 2. Capital investment trends

We have analyzed over 100 announced capital raises related to the voluntary carbon market since 2021, together with survey responses from 30 carbon project developers for this study. In total some **USD 18bn** has been raised for carbon-credit funds over 2021-2H23 with nearly **USD 3bn** of capital planned to be raised up to 2025. Over 80% of these commitments (**USD 15bn**) are for nature-based solutions, but with a recent interest in funding for carbon engineering.

**Announced capital raised for carbon projects 2021 - 2025 (USD bn)**



Total capital raised 2021 – 2023, and anticipate raises to 2025 = USD 21bn

In 2021, some **USD 7.8bn** of capital was raised for carbon-credit projects. In 2022 and 1H23 raises of **USD 6.7bn** and **USD 3.4bn** were announced, respectively.

Over 80% of announced capital raises are for nature-based projects including IFM, restoration and REDD+. 2022 and 1H23, however, saw a significant share of new capital commitments flowing to carbon engineering funds and projects such as Direct Air Capture (DACs) and Bio-energy with CSS (BECCs).

Energy Efficiency projects, in particular cookstoves, have attracted around **USD 300-500mn** of investment in the period. These project types make effective use of capital as the stoves are relatively cheap to build and distribute, for material gains in emission reductions.

(1). Source announced capital raises for low carbon investments and 30 survey responses. 400 announced capital raises were tracked. Of these 242 are/would be eligible for carbon credits, and of these, capital data are available for 100 funds. (2). Anticipated capital raises from 30 survey responses.

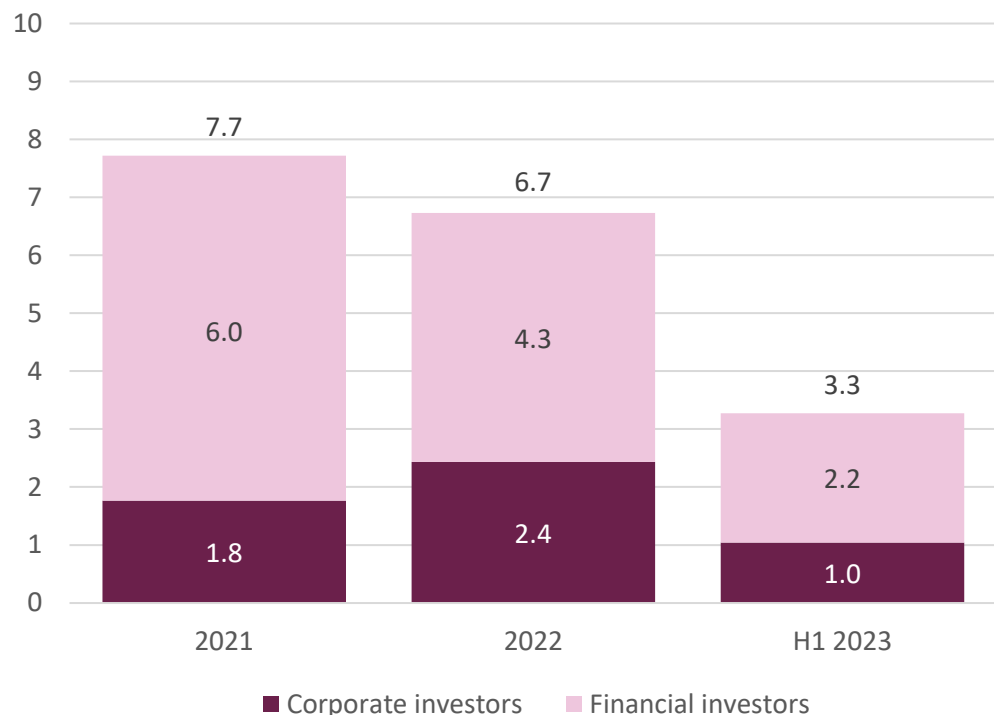
## 2.2 The role of corporate investors

## 2. Capital investment trends

A third of capital commitments to carbon-credit projects have come directly from corporates, amounting to **USD 5.2bn** since the start of 2021 to H2 2023.

Many corporates intend to make use of carbon credits and are investing in projects themselves or making advanced purchase commitments. Our analysis shows that around a third of announced financial commitments to generate or purchase carbon credits are from the corporate sector, supported by 40 - 50 major brands. This list does not include funds that intend to reduce emissions within value chains, as typically these do not generate carbon credits. For example, the First Movers Coalition, which now comprises 85 members, aims to reduce emissions across several industries including aviation, cement and shipping. The group will also invest in CDR technologies, but the emphasis is on within value chain emission reductions.

Announced capital raised by investor type (USD bn)



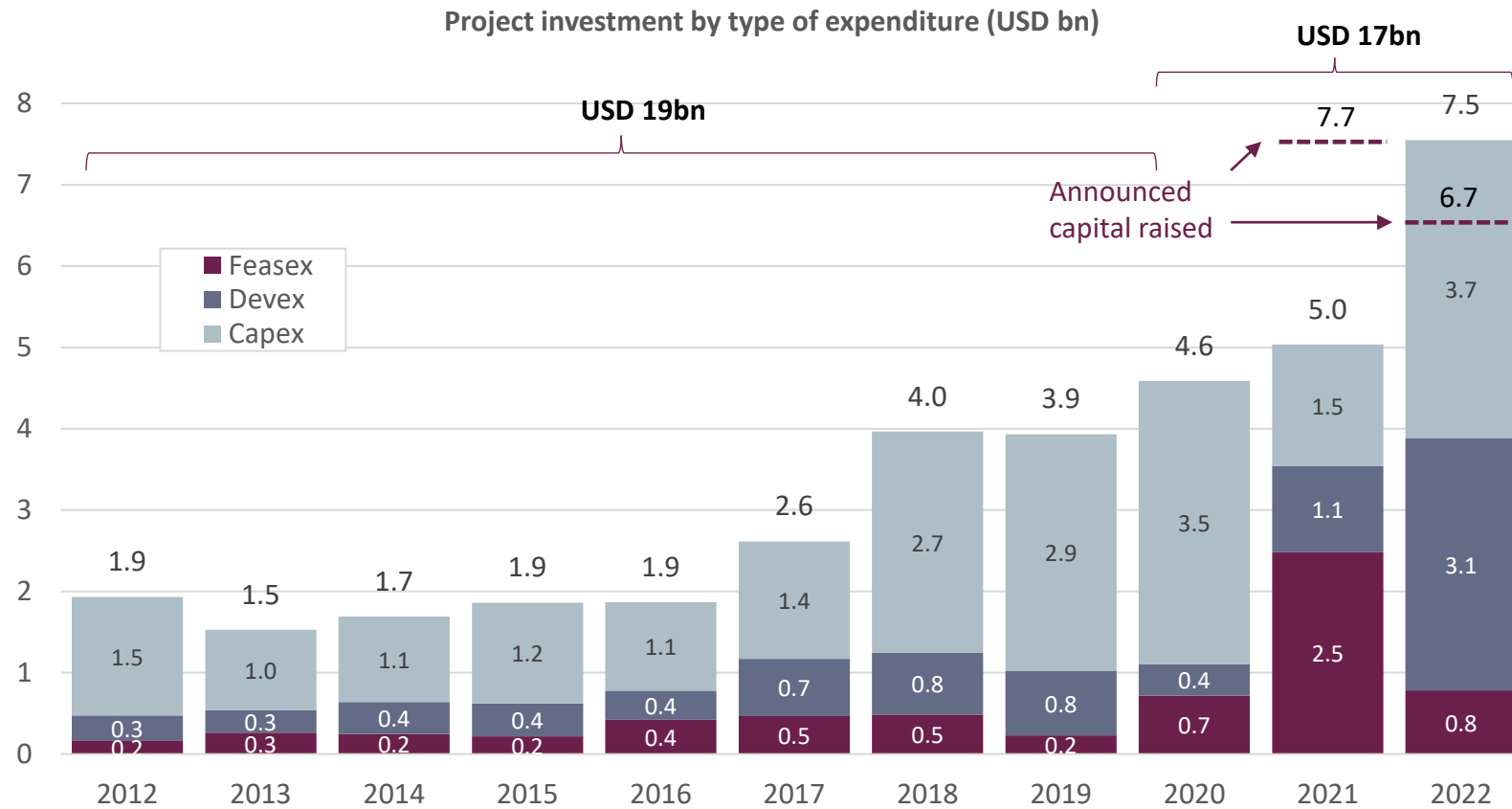
Selected corporate commitments to invest in / purchase carbon credits

Corporate(s)	Year	Focus area	(USD m)	Number of years
Shell & EKI	2021	NBS	1,600	5
H&M Group, Volkswagen, Amazon, Salesforce, Bayer, Unilever, Blackrock, E.On, McKinsey, GSK (LEAF Coalition)	2022	NBS	1,500	10
McKinsey, Stripe, Alphabet, Shopify, Meta (Frontier)	2022	CDR	925	8
Hess & Guyana	2022	NBS	750	10
Engie, Axa (Shared Wood)	2022	NBS	500	n.s.
Astra Zeneca (AZ Forest)	2023	NBS	400	7
Apple (Restore Fund)	2022-3	CDR	400	n.s.
JP Morgan	2023	CDR	200	n.s.
Bel, Chanel, Danone, Eurofins, Hermes, Mars, L'Occitane, McCain, Orange, SAP, Schneider, Mauritius CB, Voyageurs du Monde (Livelihoods Fund)	2023	NBS	160	10
Kering, L'Occitane (Climate Fund for Nature)	2022	NBS	150	n.s.
Orange	2022	NBS	50	n.s.

NBS = Nature-based solutions including improved forest management, REDD+ and afforestation / restoration.  
CDR = Carbon Dioxide Removal, including direct air capture, bio-energy with CCS, biochar and enhanced rock weathering.

## 2.3 Project investment – by expenditure type

Along with capital raised, we have analyzed capital invested in over 7,000 carbon-credit projects from 2012 to 2022. Some **USD 36bn** has been invested in carbon-credit projects over this period, with **USD 17bn** in the last three years and **USD 7.5bn** of this investment in 2022.



Since 2017, there has been a steady increase in investment in carbon-credit projects, from just under **USD 2bn** in 2017 to **USD 7.5bn** in 2022 (CAGR of over 20%).

The increase is especially notable in the years from 2020 to 2022. This has been driven by the growing corporate interest in using carbon credits to achieve climate goals.

In the years up to and including 2020 most of the investment is on building carbon-credit projects (capex). 2021 saw a significant increase in feasex as many new projects entered the development pipeline. This rapid increase in project activity fed through into 2022 with an increase in devex to just over **USD 3bn**, while feasibility activities tailed off to **USD 0.8bn**.

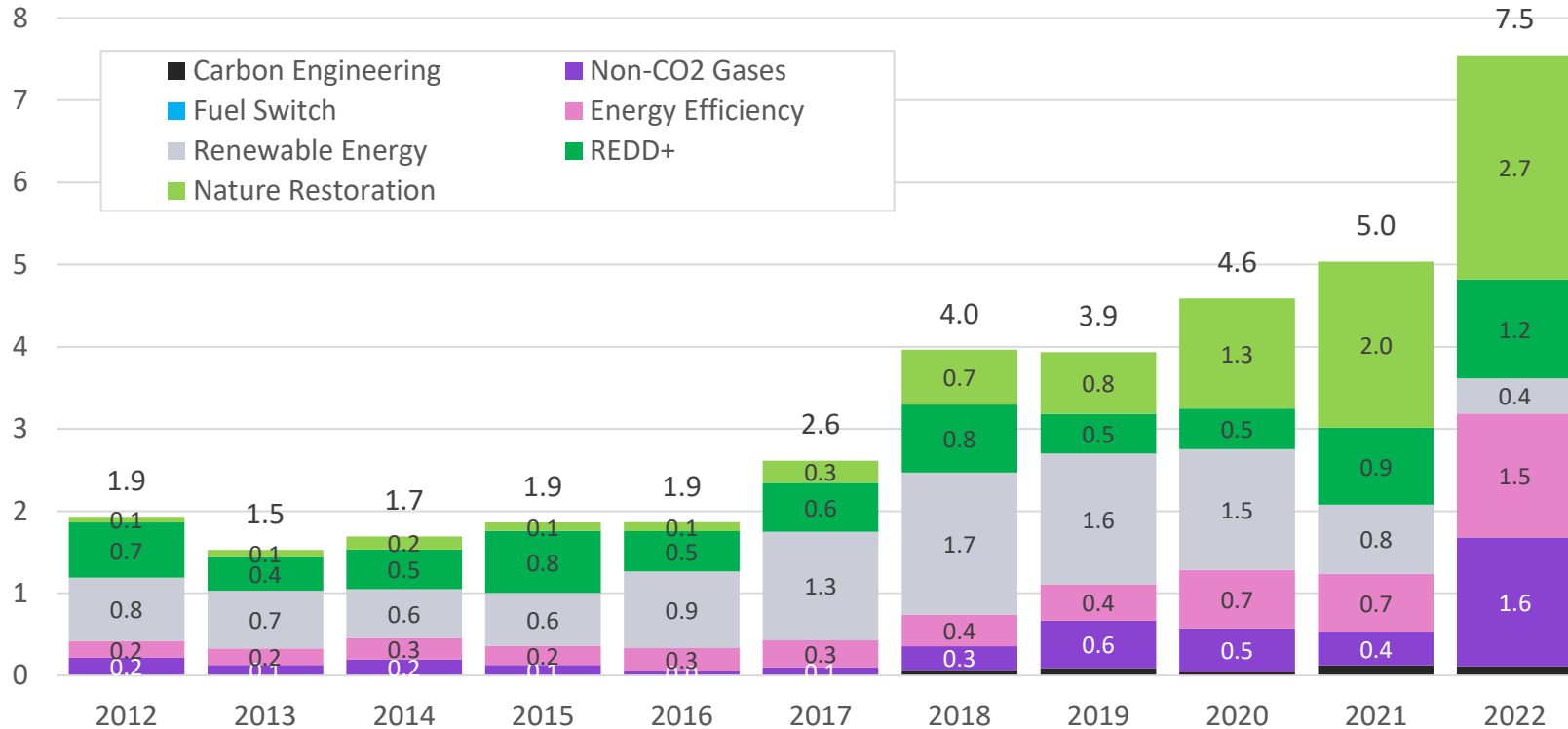
Further capital expenditure on projects currently in development will likely be required beyond 2022. We estimate some **USD 12bn** will likely be needed over the next three years, representing an annual investment of c. **USD 4bn**.

Source: Trove analysis of carbon-credit registered and pipeline projects across the five carbon-credit registries including Verra, Gold Standard, ACR, CAR and Puro Earth – as of September 2023. Methodology and assumptions are shown in Appendix A.

## 2.4 Project investment – by project type

Since 2012, just 42% of project investment has been in nature-based solutions (Nature Restoration and REDD+) representing a total of **USD 15bn**. This share has increased since 2020 to 50%, with **USD 8.7 bn** being invested in nature-based projects over this period.

Project investment by project type (USD bn)



Nature-based projects continue to account for the largest share of VCM project funding, representing **USD 8.7bn** in 2020-2022.

Renewable Energy projects represent a declining share of VCM project funding, as these projects are increasingly cost-effective without carbon-credit finance and are no longer eligible to carbon credits.

The share of funds devoted to Non-CO2 Gases, in particular methane emissions control, increased in 2022 to **USD 1.6bn**. These projects relate the capture of gases from waste-related and oil and gas pipelines.

Investment in Energy Efficiency projects doubled in 2022 to **USD 1.5bn**, mostly due to a rapid increase in cookstove projects. These projects now represent 20% of all carbon project investment.

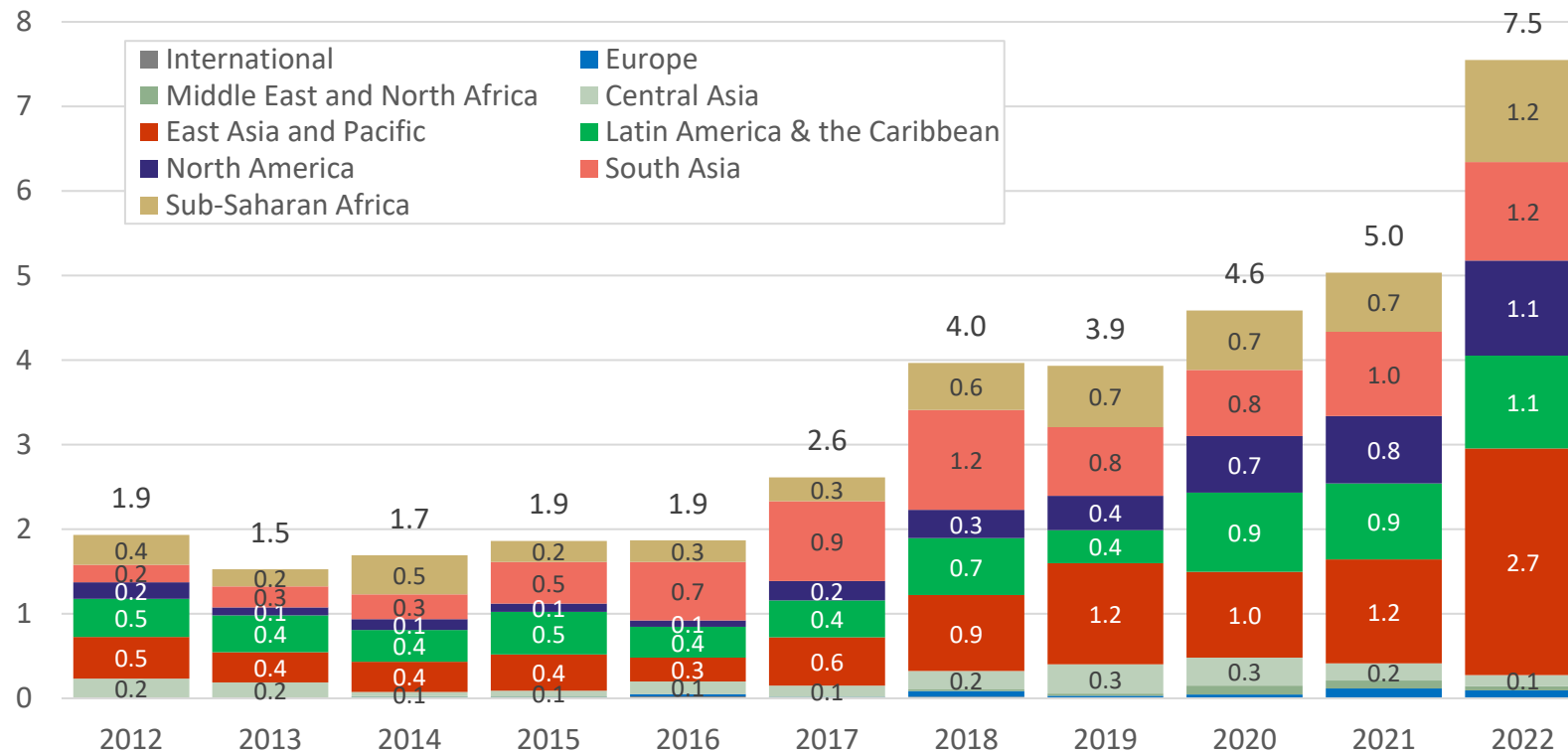
Prior to 2022, investment in Carbon Engineering projects represented a tiny fraction of the VCM, although significant sums have been raised to develop new technologies in this sector.

Source: Trove analysis of carbon-credit registered and pipeline projects across the five carbon-credit registries including Verra, Gold Standard, ACR, CAR and Puro Earth. Methodology and assumptions are shown in Appendix A – as of September 2023.

## 2.5 Project investment – by region

The largest share of carbon project investment is in the East Asia and Pacific region, followed by South Asia and Sub-Saharan Africa. In developed countries, North America is by far the largest destination for carbon-credit investment.

Project investment by region (USD bn)



East Asia-Pacific now accounts for a third of investment activity for carbon-credit projects - **USD 2.7bn** in 2022. Much of this is related to nature-based projects.

Growing sums are also flowing to Sub-Saharan Africa, which grew by 70% in 2022 to **USD 1.2bn** and represents 16% of global investment.

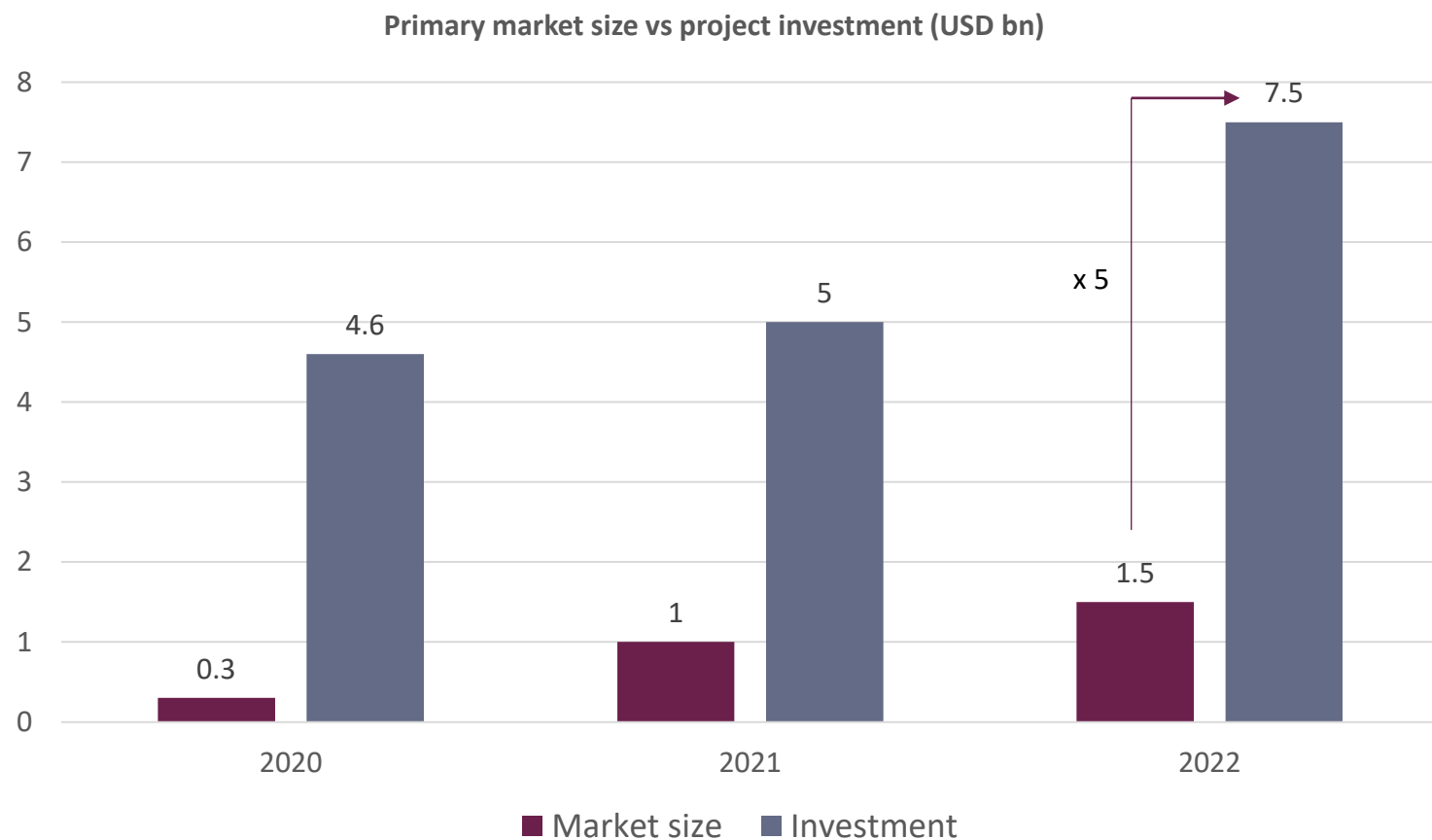
Central Asia has seen declining inbound investment, and now accounts for around 2% of new project investment, compared to 9% in 2019.

Since 2020 North America has remained consistently the destination for 15-16% of global project investment. This contrasts with Europe which now accounts for around 1% of global investment.

Source: Trove analysis of carbon-credit registered and pipeline projects across the five carbon-credit registries including Verra, Gold Standard, ACR, CAR and Puro Earth – as of September 2023. Methodology and assumptions are shown in Appendix A.

## 2.6 Capital investment compared to market size

Capital investment in carbon-credit projects is currently running five times greater than the value of the primary carbon-credit market. This is indicative of industry expectations for significant growth. In mature industries the ratio of capital investment ratios to sales is typically less than 1.0.



*The primary market for carbon credits - defined as the volume of carbon credits retired multiplied by the yearly average price - was worth around **USD 1.5bn** in 2022.*

*Other published figures on the size of the voluntary carbon market may cite higher numbers, but these often refer to total traded volume. USD 1.5bn is the primary market, i.e. the value of retired credits.*

*USD 1.5bn is roughly a fifth of the value of investment flowing into new carbon projects. This is indicative of an industry planning for significant growth. In a mature industries - even high capital expenditure industries such as oil and gas or telecoms - capital investment runs at a fraction of sales, typically less than 1.0.*

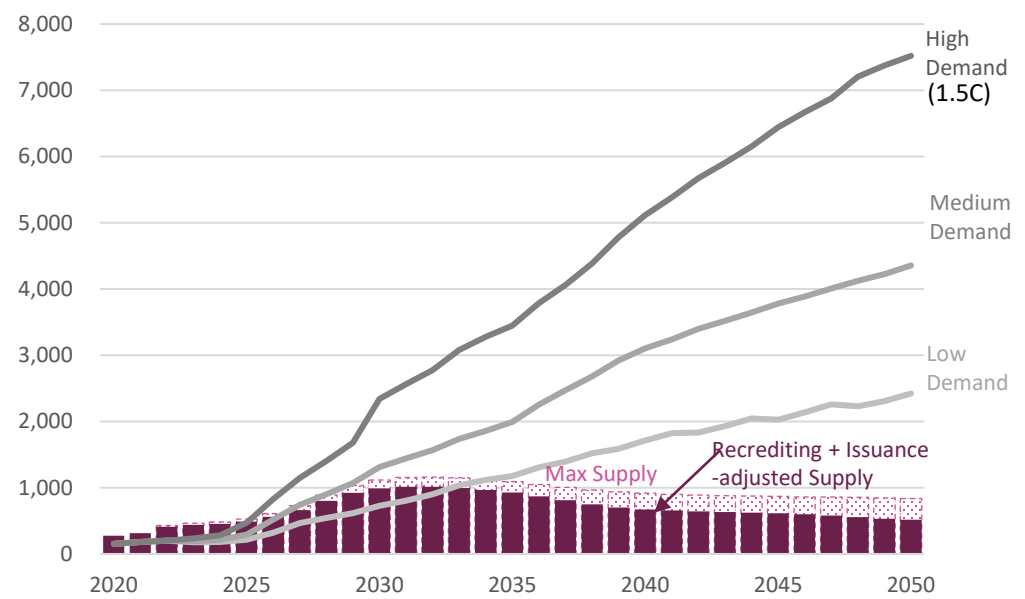
Source: Trove Research, as of September 2023.

## 2.7 Future capital investment requirements

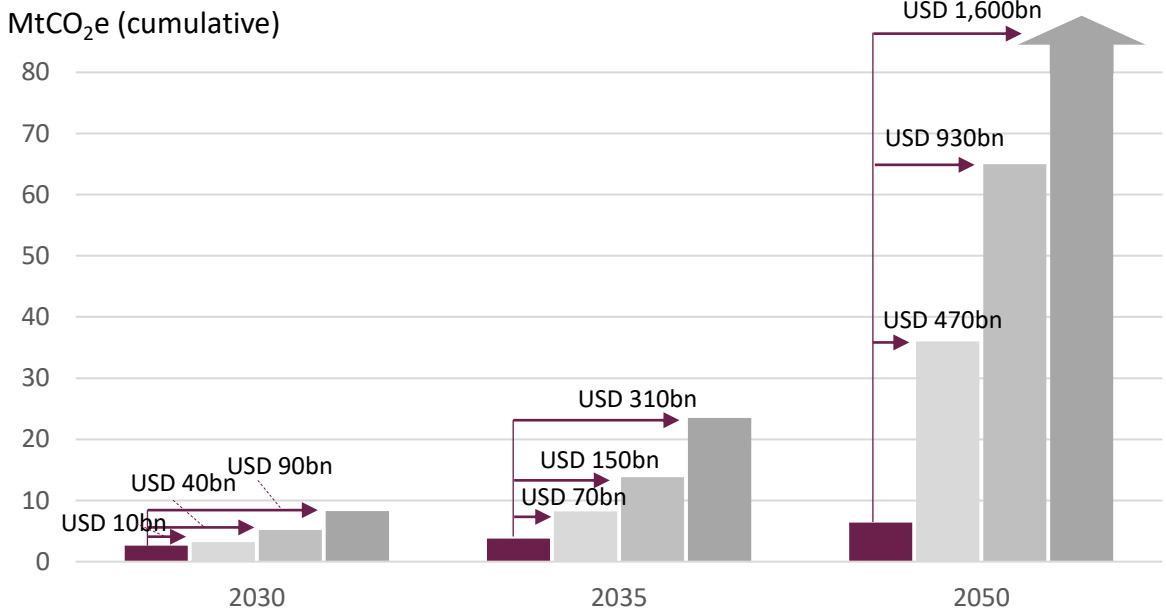
The **USD 36bn** invested in carbon-credit projects since 2012 is a **third** of the total investment needed to meet credit demand under a 1.5C scenario by 2030. A further **USD 60bn** of capital is expected to be needed under this scenario by 2030 and **USD 310bn** by 2035. Under more modest expectations of demand, a further capital investment of USD 10bn to USD 40bn is expected to be needed by 2030. This capital will be to build out projects already in the pipeline.

Trove regularly updates its scenarios for potential demand, supply and prices of carbon credits to 2050. This analysis indicates a surplus of credits until 2030 under low and medium demand scenarios, but a shortage under the high demand scenario. However, around half of this supply to 2030 will likely come from projects in the pipeline. These will likely need capital expenditure to develop. Over time, new projects become more costly to build and operate as older projects are retired, higher quality standards drive a greater focus on additionality and access to resources, such as land for nature-based projects, becomes scarcer.

Annual supply and demand – all credits (MtCO<sub>2</sub>e/yr) <sup>(1)</sup>



Cumulative demand and supply of credits and capital investment needed to 2050



1. Demand includes potential demand from corporates net zero targets (SBTI and non-SBTI approved), carbon neutral claims, CORSIA, compliance schemes, and governments under Art 6.2/6.4. Supply includes registered and pipeline projects. By 2030 roughly half of credits supply will likely come from registered and half from pipeline projects. Source: Trove Research analysis as of September 2023.

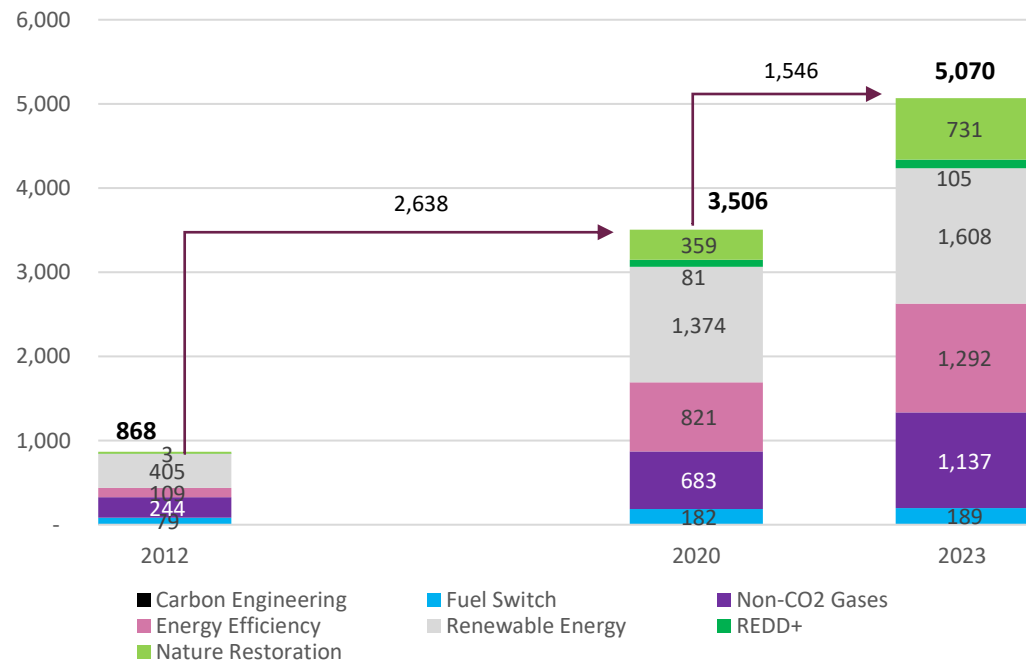
## 3. Outcomes and co-benefits

# 3.1 Outcomes – carbon reductions

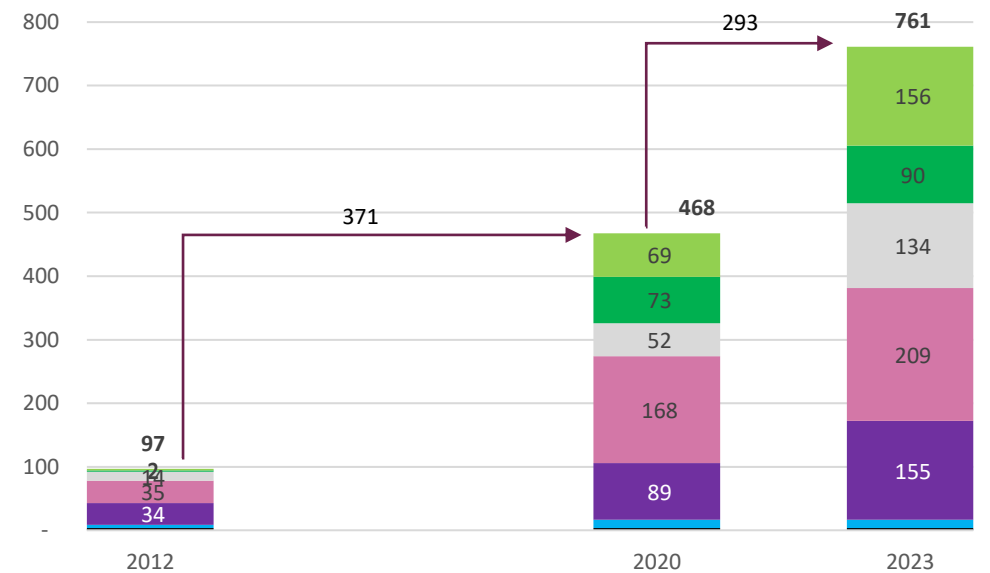
Since 2020 over **1,500** new carbon-credit projects have been developed and registered with the five main registries. This is equivalent to around 520 new projects a year. The rate of new project registrations in the last three years is 160% of the rate from 2012 to 2020. The new projects added since the start of 2020 claim to save an additional **300MtCO<sub>2</sub>e/yr** of carbon emissions – roughly the same as the annual carbon emissions of the U.K.

*The surge in investment in carbon-credit projects since 2020 has generated around 1,500 new projects. Some 372 of these are for Nature Restoration (afforestation, reforestation and improved forest management) and 24 for REDD+. One of the largest growth sectors has been Energy Efficiency, in particular cookstove projects. Around 470 new energy projects have been registered in the last three years. Together, these projects claim to reduce an additional 300MtCO<sub>2</sub>e/yr. Some of these projects may not deliver the entire climate benefits they claim. A more realistic estimate of the actual climate benefit is likely to be emission reductions of 150 - 300MtCO<sub>2</sub>e/yr.*

**Number of registered projects <sup>(1)</sup>**



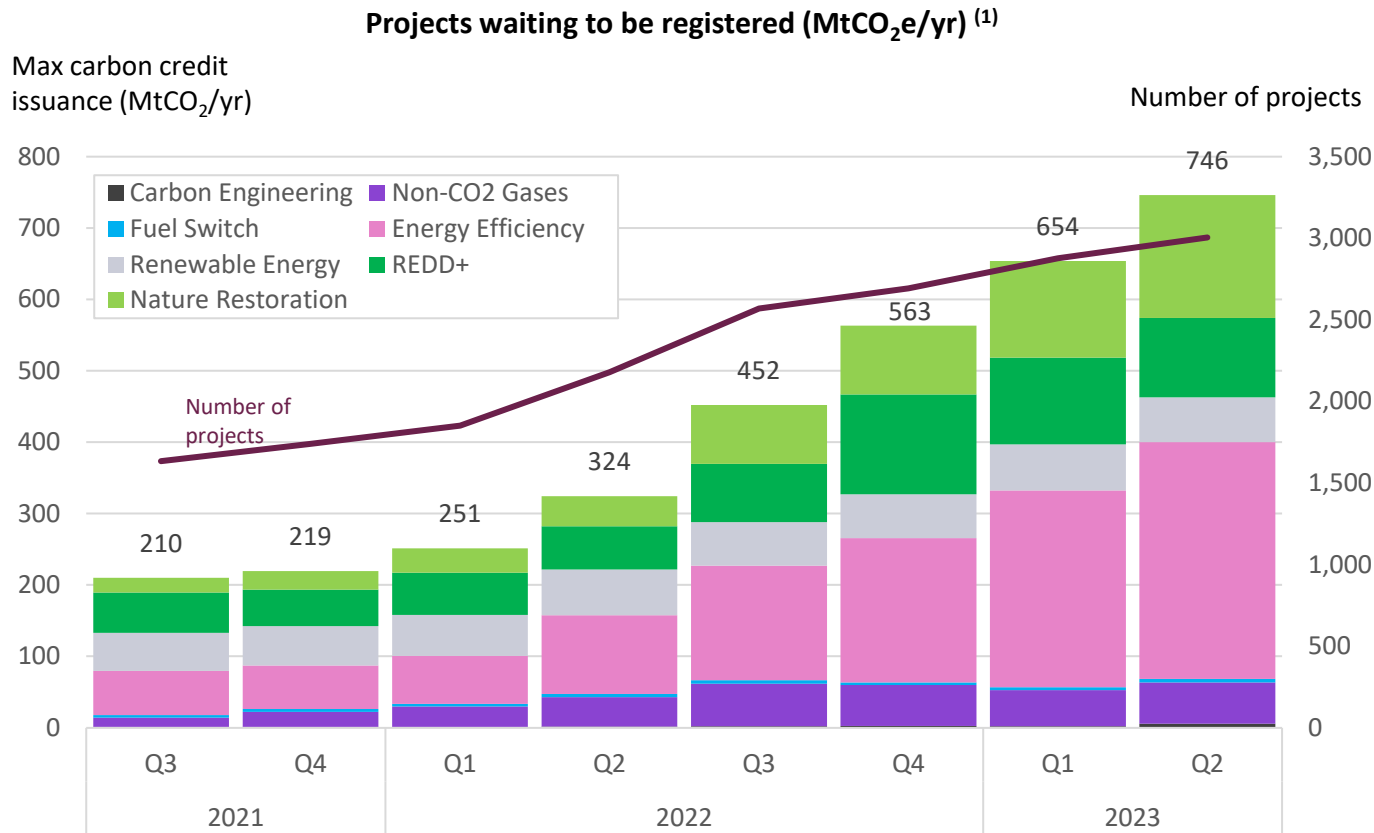
**Expected annual carbon reductions from registered projects (MtCO<sub>2</sub>e/yr) <sup>(2)</sup>**



1. From Verra, Gold Standard, ACR, CAR.
2. Annual average reductions in carbon credits claimed in project Product Design Documents

# 3.1 Outcomes – carbon reductions

In addition to the growth in the number of registered projects, there are now over 3,000 projects waiting to be registered. This pipeline has grown by 1,500 since 2021. If fully implemented, these new projects could deliver a further 530Mt/yr of emission reductions.



Since 2021 there has been a surge in investment in early-stage projects, with 1,500 new projects being added to the development pipeline, representing an additional 530Mt of annual emission reductions. This is more than the current capacity of all registered projects.

Many of these projects are nature-based solutions and Energy Efficiency, in particular, cookstoves in rural parts of Africa, Asia and South America.

Investment in early-stage projects includes feasibility studies and then more focused development to produce detailed project designs and process the project through registration. Considerable sums can be spent on these activities.

High quality projects are challenging to identify and develop, and costs are increasing. In the nature-based sector, the right land with suitable counterparties is needed to ensure minimum quality standards while being economic to develop.

1. From the four main registries: Verra, Gold Standard, ACR and CAR.

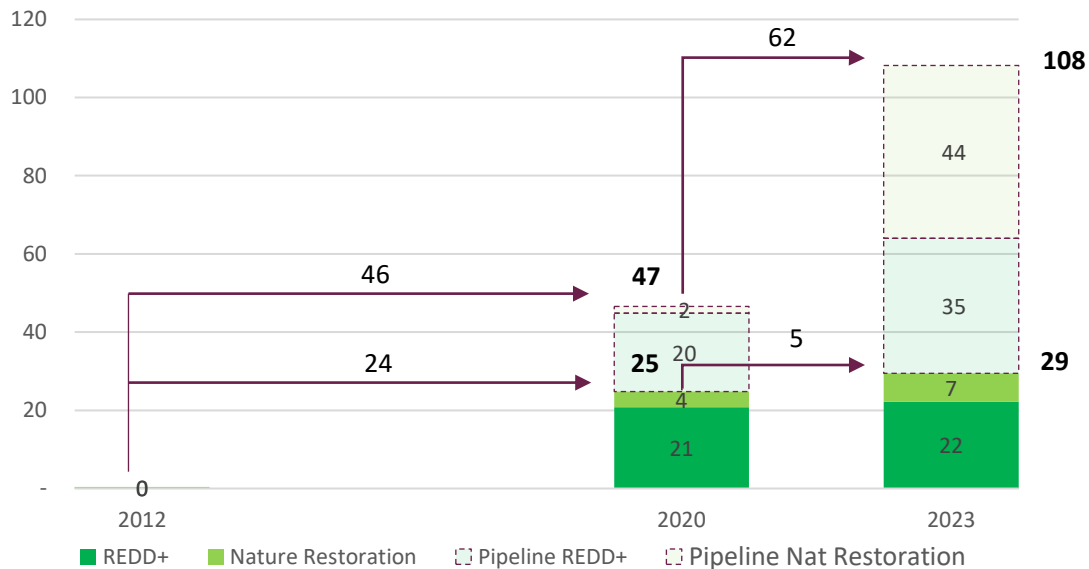
## 3.2 Outcomes – protecting and enhancing nature

## 3. Outcomes and benefits

As of July 2023, the 246 registered nature-based projects across the world now cover an area of around 30mn ha. This is an area equivalent to the size of Italy, Poland or Ecuador. Three quarters of this area is devoted to REDD+ projects to protect forests, most of which are in tropical countries. A further 80mn ha are currently under development as carbon projects – an area the size of Turkey or Mozambique.

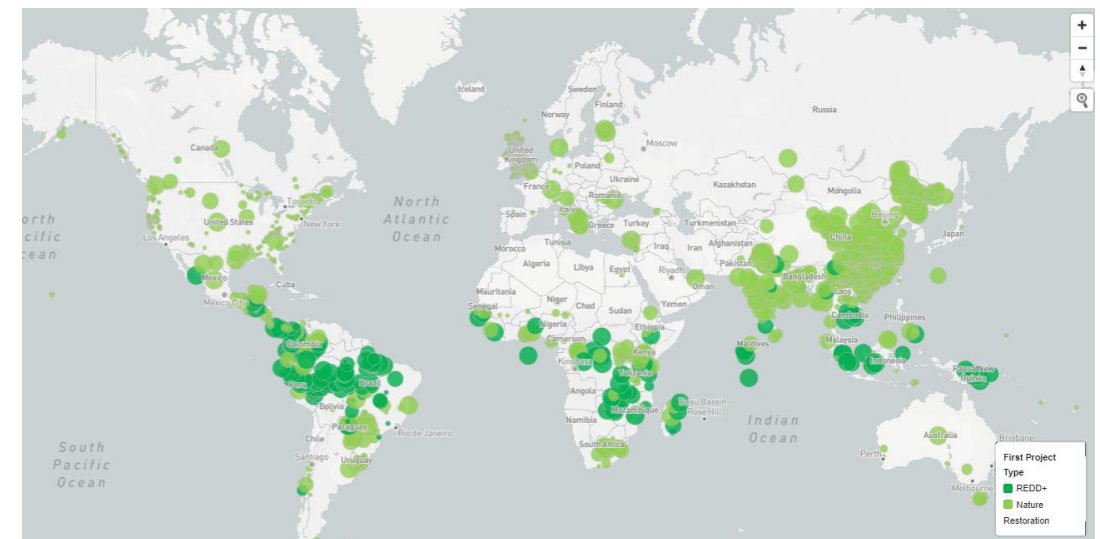
*As of July 2023, around 30mn ha of land has been registered as carbon projects for forest protection, afforestation, reforestation and improved forest management. This has grown from 25mn ha in 2020. Nature-based projects take a long time to develop, and much of the capital raised in the last three years for these projects is currently in development. These early-stage projects have the capacity to restore / re-forest an additional 44mn ha of land and protect 35mn ha from deforestation.*

Land area covered by registered and pipeline Nature Restoration and REDD+ carbon projects (Mn ha)



Source: Trove Research analysis of five main global carbon registries – as of September 2023.

Registered Nature Restoration and REDD+ carbon projects

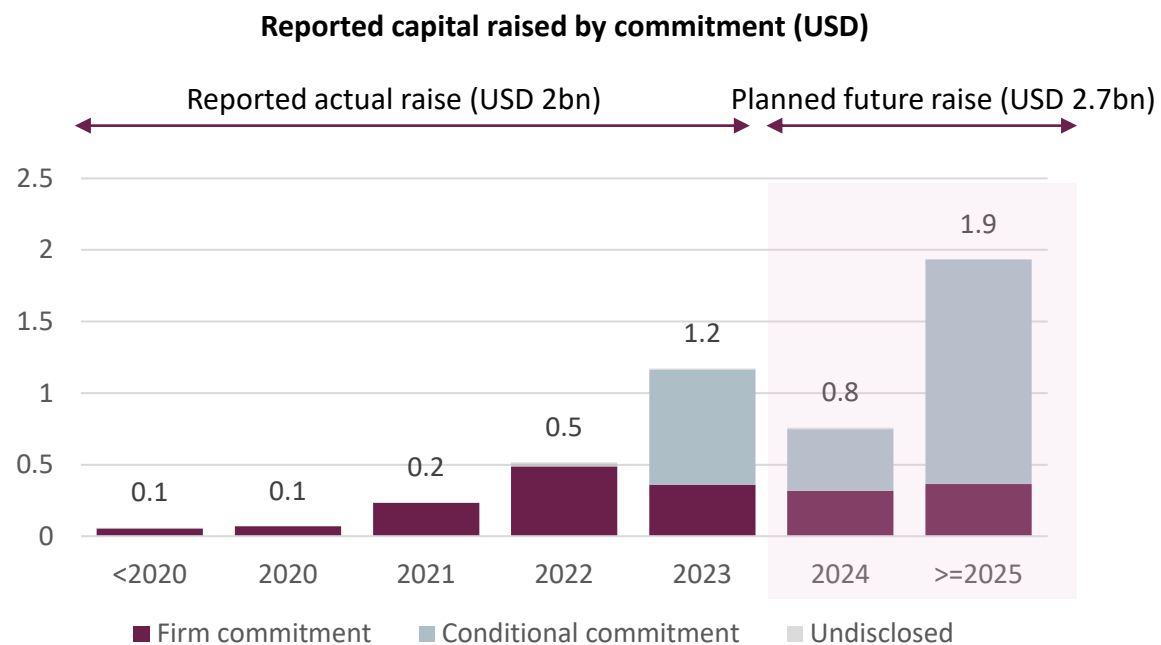


Source: Trove Research analysis of 14 global carbon registries – as of September 2023.

# Appendices

## Appendix A: Survey responses

Trove conducted an extensive survey of market participants from April and early May 2023, with support from Verra and IETA. Complete responses were received from 28 organizations. These were largely project developers or in financial services. The majority of respondents were based in North America and Brazil.



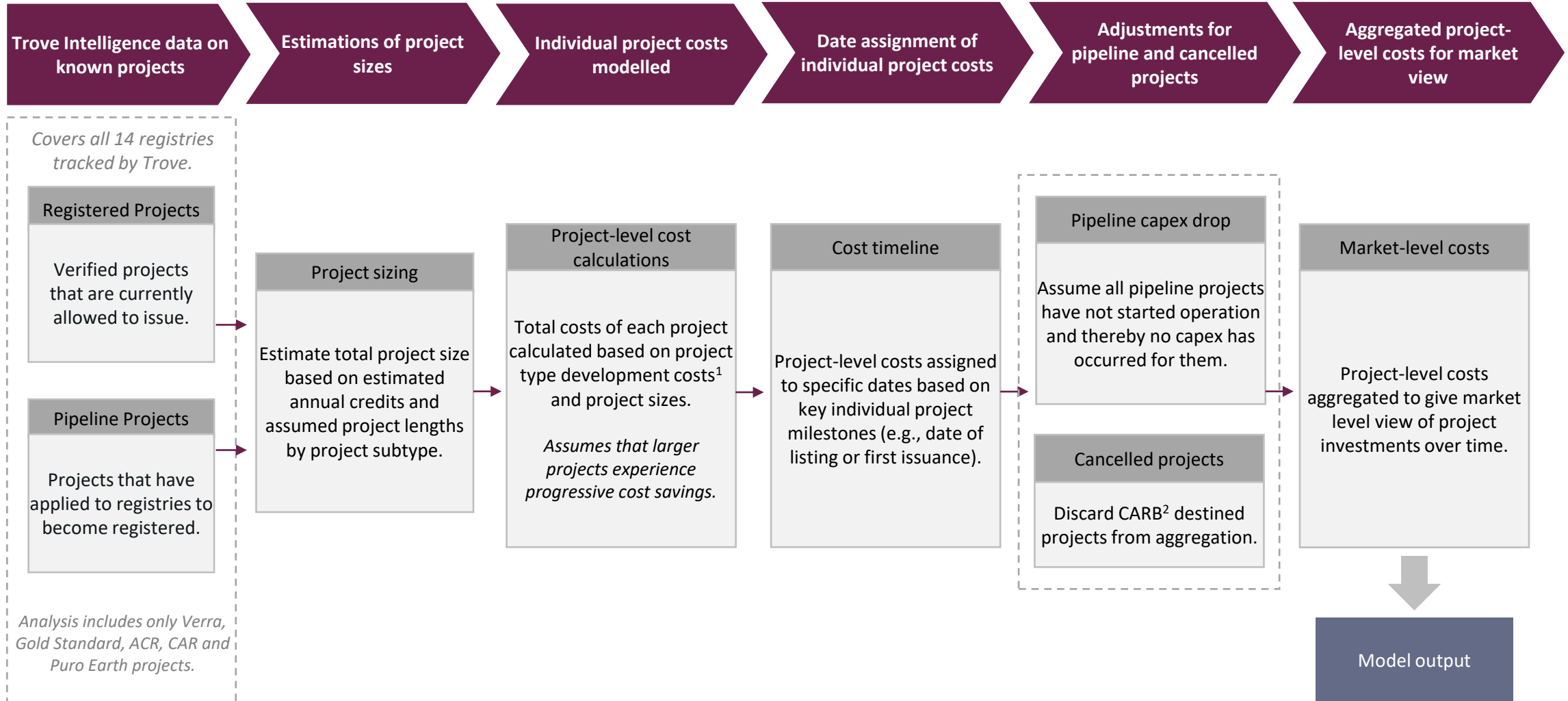
### Responses by country

Type	Count	%
Canada	5	18%
United States	5	18%
Germany	2	7%
Netherlands	3	11%
Norway	1	4%
Brazil	6	21%
India	1	4%
Switzerland	1	4%
United Kingdom	2	7%
Mexico	1	4%
Colombia	1	4%
<b>Total</b>	<b>28</b>	<b>100%</b>

### Responses by company type

Type	Count	%
Project developer	13	46%
Financial services	12	43%
Intermediary	1	4%
Government body	1	4%
Corporate	1	4%
<b>Total</b>	<b>28</b>	<b>100%</b>

# Appendix B: Investment model methodology



1. Project development cost factors were derived in-house from information available from PDDs, academic literature, spatial models and expert interviews.

2. CARB – California Air Resources Board projects are “cancelled” from the voluntary market and therefore any calculated investment towards them has been removed from the final aggregated market-view.

Source: Trove Research analysis as of September 2023.

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