XPRIZE CARBON REMOVAL | MUSK FOUNDATION

CDR INNOVATION LANDSCAPE & 2024 OUTLOOK

SEPTEMBER 2023

WE GRATEFULLY ACKNOWLEDGE THE CONTRIBUTIONS OF ALL THOSE WHO MADE THIS REPORT POSSIBLE:

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Thank you to all of the teams who have taken on the challenge of competing for the XPRIZE Carbon Removal.

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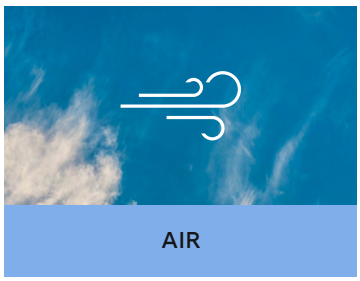
INTRODUCTION

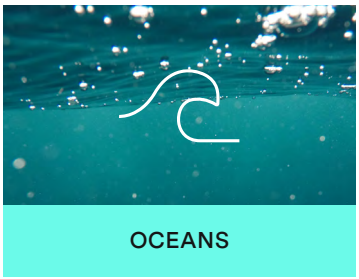
XPRIZE Carbon Removal launched in 2021 with an ambitious goal in mind: To catalyze the global supply of cost-effective, durable carbon removal solutions. Removing gigatonnes of carbon dioxide (CO_2) from the environment will require the deployment of a whole new industry, and we set out to accelerate this growth by launching the largest prize in history.

The competition requires Teams to build a working demonstration that removes at least 1,000 net metric tonnes of CO_2 from the air or ocean over one year. To win, Teams will be evaluated on the performance of their kilotonne scale demonstration, their modeled cost at the megatonne scale, and their plan for scaling up their solution sustainably and responsibly to gigatonnes of removal annually. Promising solutions will minimize impacts and maximize benefits for both the environment and communities. Responsible deployment needs to be front and center so that this new industry can be built with equity and justice in mind from the ground up.

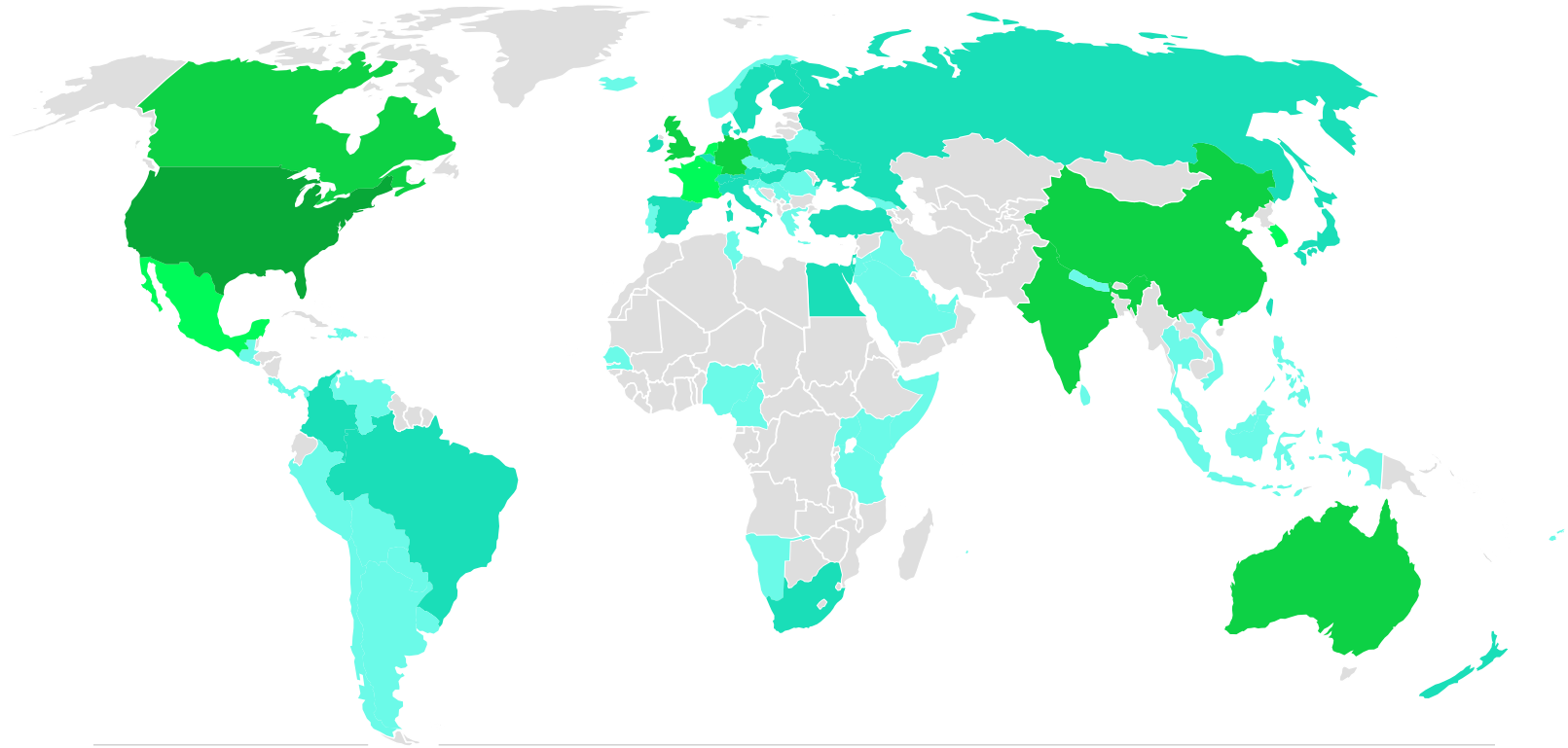
To date, XPRIZE has awarded $20M, with $5M distributed to 23 Student Teams, and $15M awarded to 15 Milestone Winners. The Grand Prize winner will take home $50M, and $30M will be distributed amongst runners up chosen by the Judges in April 2025.

This report summarizes data collected from Teams who registered for the competition between April 2021 and September 2023. Leading up to the final registration deadline on September 7, 2023, Teams planning to continue in Phase 2 of the competition were asked to complete an “Intent to Compete” questionnaire affirming their participation and sharing updates about the status of their projects. The majority of data in this report is taken from that submission.





INDUSTRY OVERVIEW



Map of the 1,334 Qualified Teams from the XPRIZE Carbon Removal Milestone Round

1-5 6-20 21-50 51-100 100+

Since the launch of XPRIZE Carbon Removal, 1,334 Teams from around the world have joined the competition. These Teams represent 88 countries and a full range of carbon removal pathways, with efforts spanning Air, Land, Oceans, and Rocks.

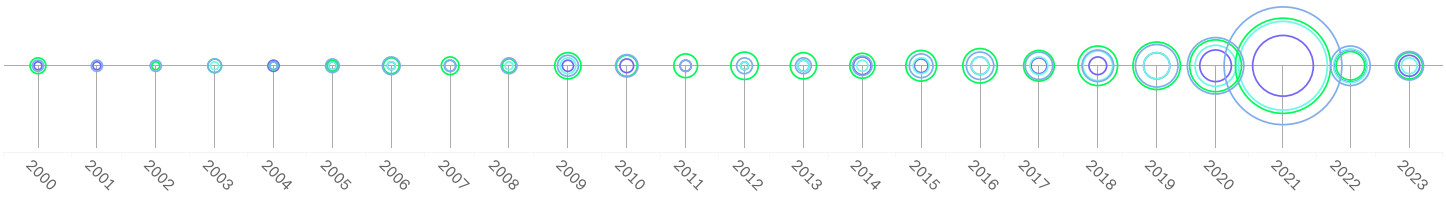
With upwards of 8,400 individual team members, a broad range of demographics and backgrounds are represented including scientists, engineers, technologists, students, and other newcomers to the field.

GROWTH

The carbon removal industry has seen tremendous growth in recent years. 2021 was the biggest year of growth across all four tracks, with 50% of teams being founded since the prize launched in 2021.

The 1,001 Teams who are not actively moving forward with their competition entry still represent a huge source of potential growth for the CDR industry. These Teams represent the “next generation” of innovators that will continue to develop early stage technologies and scale up projects in the coming years.

YEAR FOUNDED



NUMBER OF TEAMS FOUNDED

	2018	2019	2020	2021	2022	2023
AIR	16	29	51	222	25	13
LAND	25	36	43	145	13	11
OCEANS	14	11	27	126	18	4
ROCKS	5	11	16	59	17	7

BREAKING GROUND

As of September 7, 2023, 333 Teams have indicated that they are ready to demonstrate a working carbon removal project in 2024.[1] 53% of these companies were founded since the prize launched in 2021. The full list of Teams is available in Appendix A. These Teams represent a significant portion of the active carbon dioxide removal industry.

This pool of 333 Teams represents both competitors who have been active from the beginning of the competition as well as new entrants to the competition. Of the Teams who competed in the Milestone Round of the competition (announced in April 2022), 52 of the Top 60 Teams, and 139 of the 287 Qualified Teams are continuing to compete. Since 2022, an additional 119 Teams have joined the competition, showing continued growth and evolution of the industry in the last year. Registration for the competition is now officially closed.

GEOGRAPHIC BREAKDOWN

The majority of projects represented in this cohort are based in North America (44%), but there is also significant activity in Europe (20%) and Asia (19%). There are relatively few projects at this level of maturity currently in the global south. However, there was stronger representation in the larger 1334 cohort. We hope those Teams continue to advance. The data also shows that 74 teams (22%) are developing their projects in a country other than their headquarter country, demonstrating the global nature of the CDR industry.

TRACK	N. AMERICA	S. AMERICA	AFRICA	ASIA	OCEANA	EUROPE
AIR	54	5	5	24	3	16
LAND	57	14	8	16	7	24
OCEANS	20	6	1	14	3	12
ROCKS	14	2	2	9	4	13
TOTALS	145	27	16	63	17	65

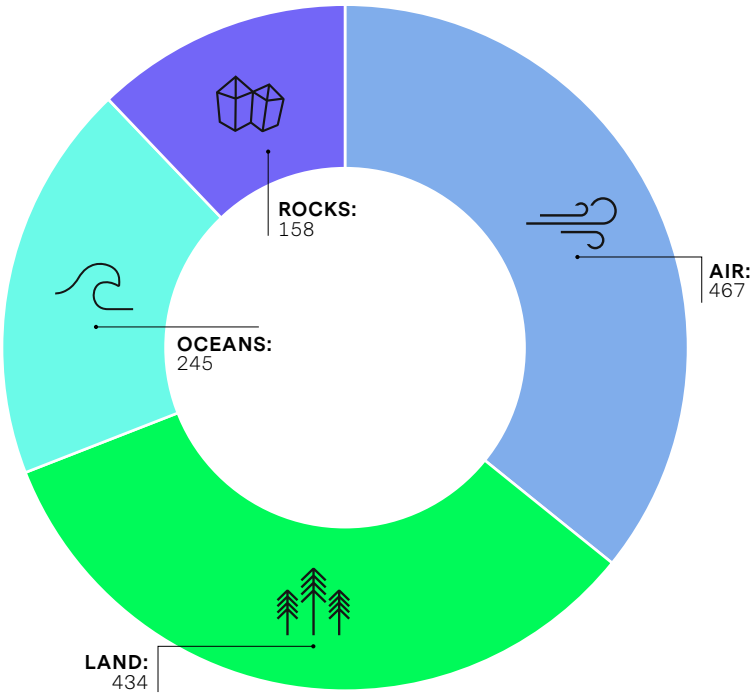
[1] Responses were screened for overall quality, but the benefit of the doubt was given to the applicants. Figures reported by teams have not been verified by XPRIZE. XPRIZE received 368 responses and omitted 35 for this analysis.

Companies or individuals may submit multiple entries to the competition: We refer to each entry as its own “Team”, but recognize that multiple projects from the same company may be represented in the dataset of 333 Teams.

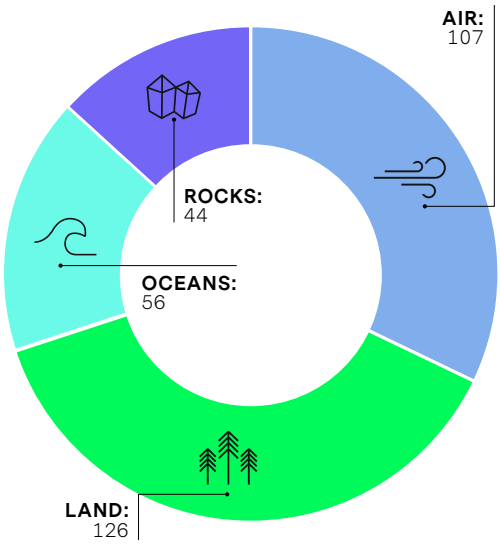
BREAKDOWN BY CDR TRACK

The carbon removal industry comprises a wide range of different removal pathways – all of which are eligible for the competition (presuming they meet the requirements outlined in the guidelines, including a minimum durability threshold of 100 years). We consider these pathways as falling into four broad "tracks": Air, Land, Oceans, and Rocks. These tracks are described in more detail in later sections of this report.

1,334 REGISTERED TEAMS [2]



333 ACTIVE TEAMS



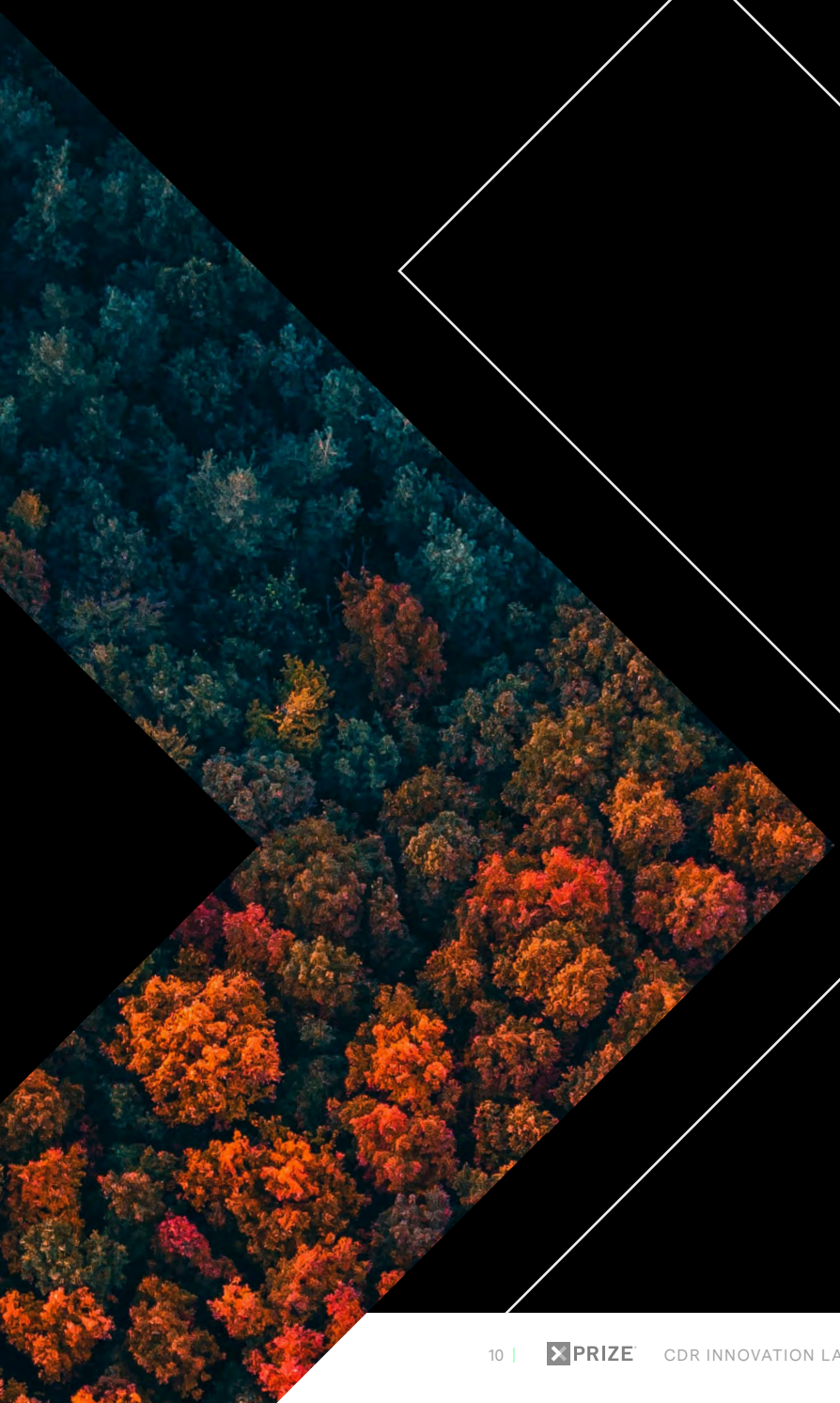
The lines between these four tracks are not solid. In fact, all of our data suggests that a majority of Teams are pursuing what may be considered 'hybrid' solutions. Of the 333 Teams surveyed in 2023, 203 (61%) indicated hybrid approaches. The following 2-track combinations were most commonly reported from the 333 respondents:

16%	13%	10%	9%	8%	3%
AIR + LAND: 52	**AIR + ROCKS:** 43	**AIR + OCEANS:** 34	**LAND + OCEANS:** 30	**LAND + ROCKS:** 26	**OCEANS + ROCKS:** 11

[2] An additional 30 Teams not shown here registered in an "MRV" track, which was a track special to the 2021 Student competition.

2024 OUTLOOK

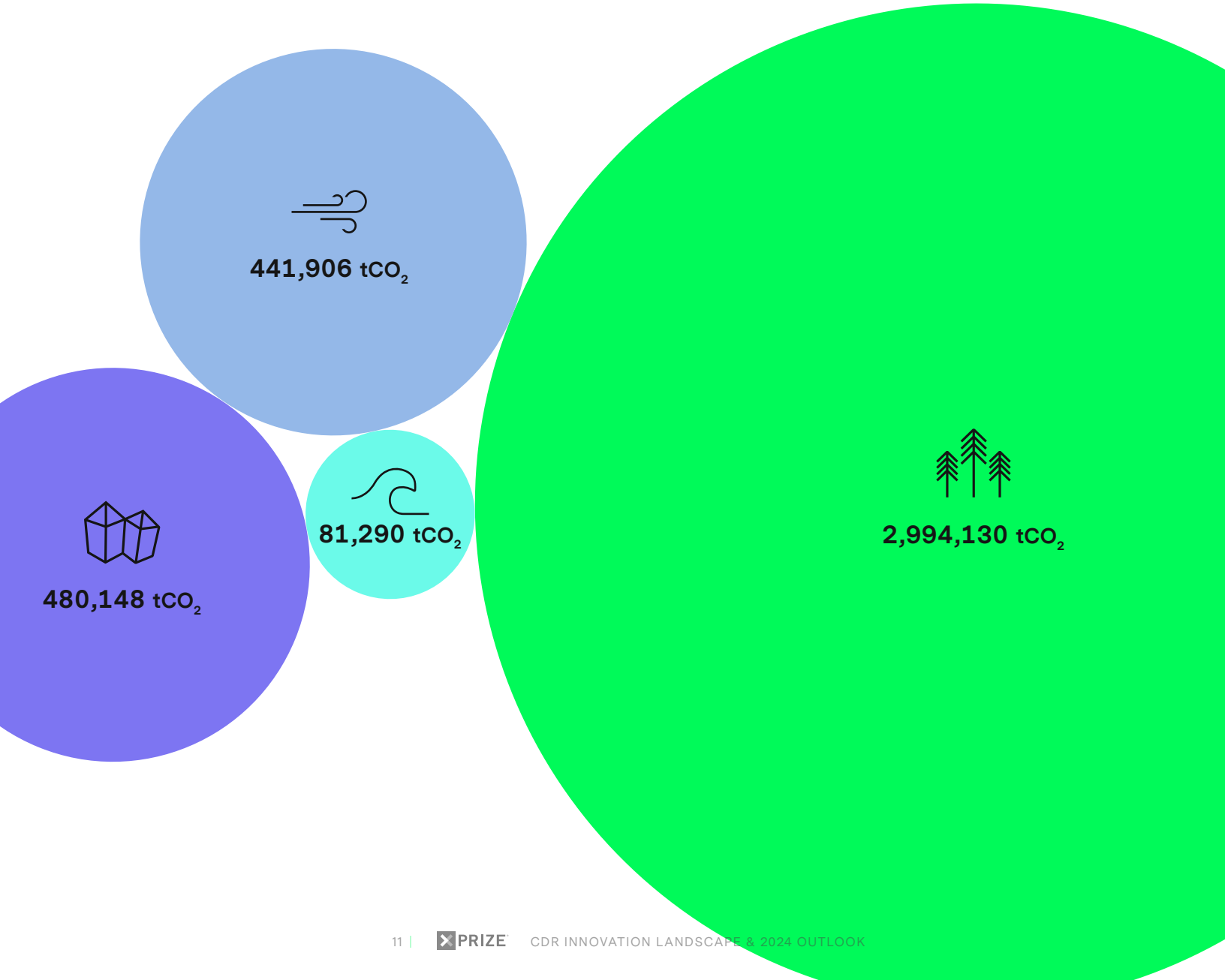
XPRIZE CARBON REMOVAL



The goal for XPRIZE Carbon Removal is to produce a working demonstration that can remove 1,000 net metric tonnes of CO_2 during a 12-month period (February 1, 2024 - January 31, 2025).

Collectively, the 333 responding Teams stated they plan to remove 3,997,474 tonnes of CO_2 during that period. Broken down by track, Land Teams plan on removing the majority of this figure.

PLANNED CO_2 REMOVAL DURING 1 YEAR DEMONSTRATION



Within the cohort there is a vast distribution of planned removal volumes.

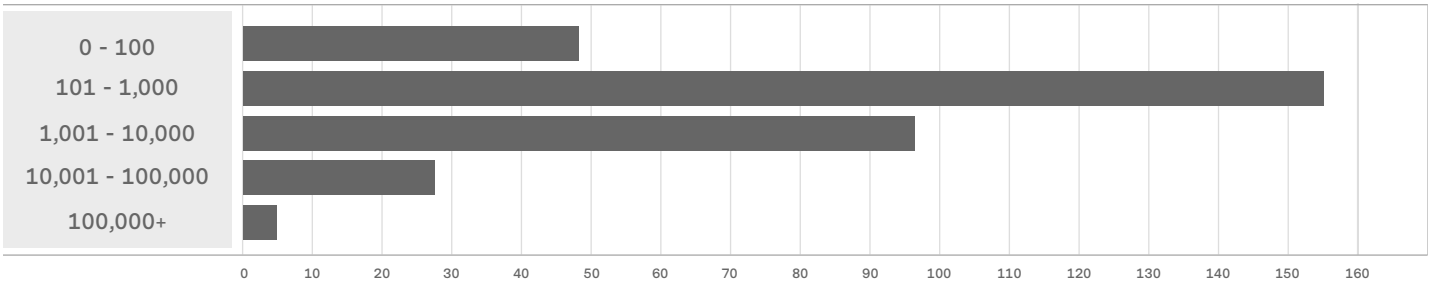
Ordered by scale, the middle 50% of Teams (2nd and 3rd quartile) report a scale of 500-2000 tonnes, spanning the target scale for the competition. However, the vast majority of planned removal tonnage (90% of the planned total) is promised by just 33 Teams (10% of the cohort).

	NUMBER OF TEAMS	PLANNED SCALE (tonnes / year)	PLANNED REMOVAL IN 2024 (Cumulative)
QUARTILE 1	84	0-500	15,754
QUARTILE 2	83	500-1,000	79,123
QUARTILE 3	83	1,000-2,000	96,076
QUARTILE 4	50	2,000-10,000	232,083
	33	10,001+	3,574,438
	333	**TOTAL**	**3,997,474**

PLANNED SCALE OF CO_2 REMOVAL

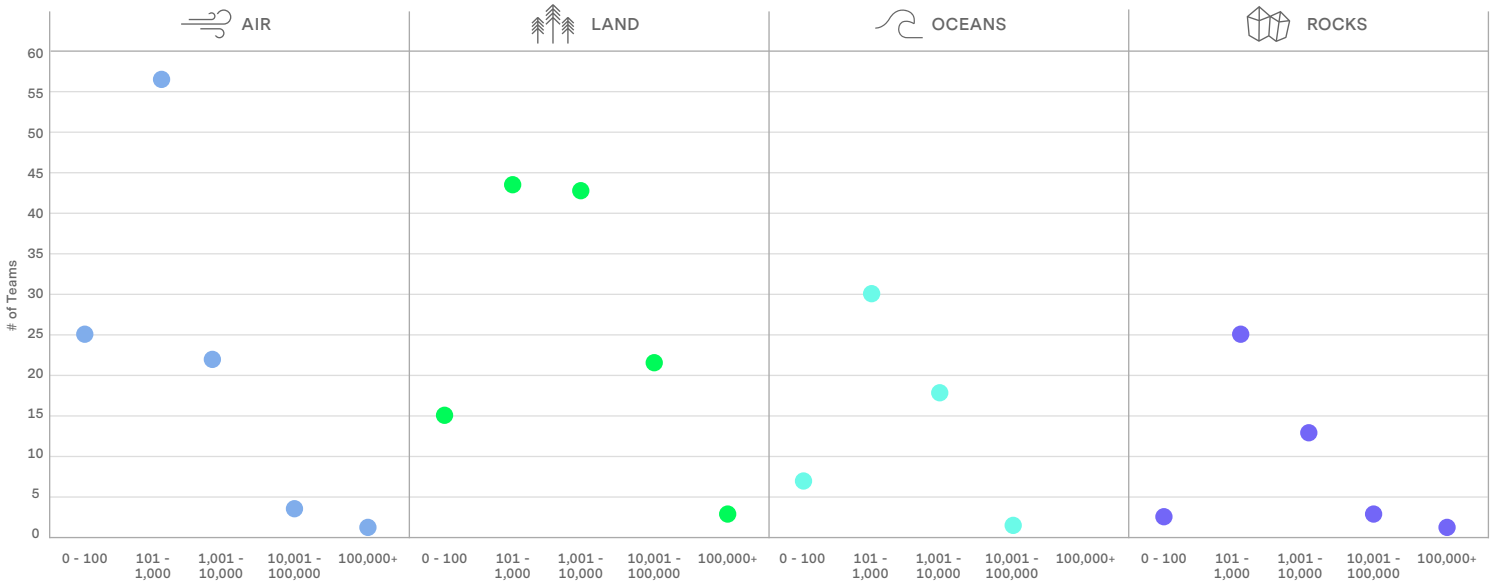
For many Teams working on first-of-a-kind technologies, the 1,000 tonne competition requirement represents a stretch goal. For more established types of removal (or more established companies), exceeding the goal will be possible.

PLANNED SCALE OF CDR PROJECT (tCO_2)



The responses to our survey show that Teams developing Land solutions tend to have larger scale demonstrations, while Teams developing Air solutions tend to have smaller scale demonstrations. Of the 83 largest planned projects, 54 (65%) are Land solutions, while the smallest 84 projects are majority Air solutions (43 projects, 51%).

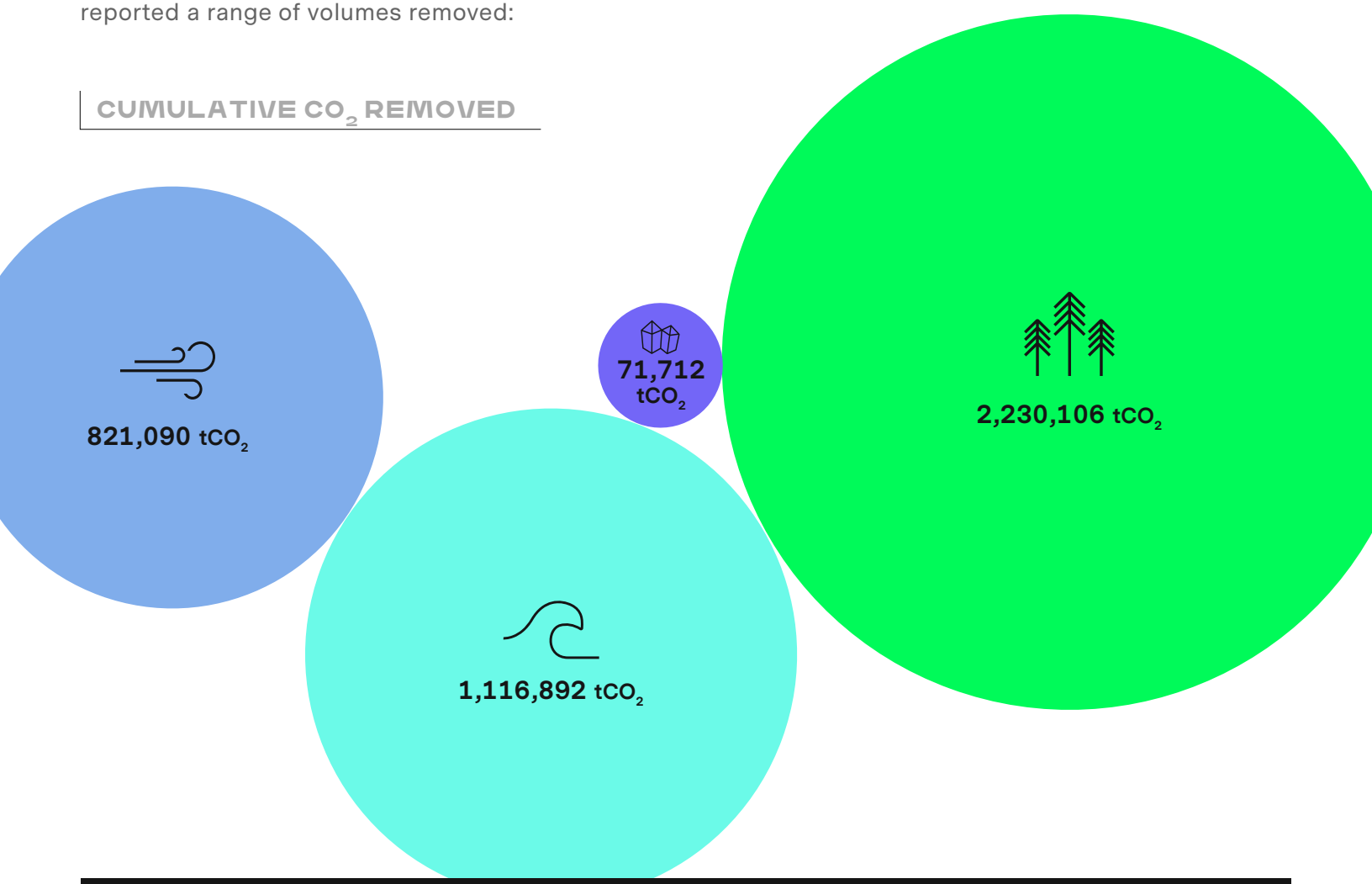
PLANNED CO_2 REMOVAL RANGE (tCO_2)



CO_2 REMOVED TO DATE

In addition to the 2024 numbers, Teams were also asked to share the volume of CO_2 sequestered to date since their founding. Collectively, they reported having removed 4,239,800 tonnes of CO_2. However, this headline number does not offer a realistic profile of the CDR industry by itself: of the 333 teams, 170 Teams reported having removed no CO_2 at all to date, while just 2 Teams claimed to have removed the bulk of the top line figure (2,900,000 tonnes between them). In between these two extremes, Teams reported a range of volumes removed:

CUMULATIVE CO_2 REMOVED



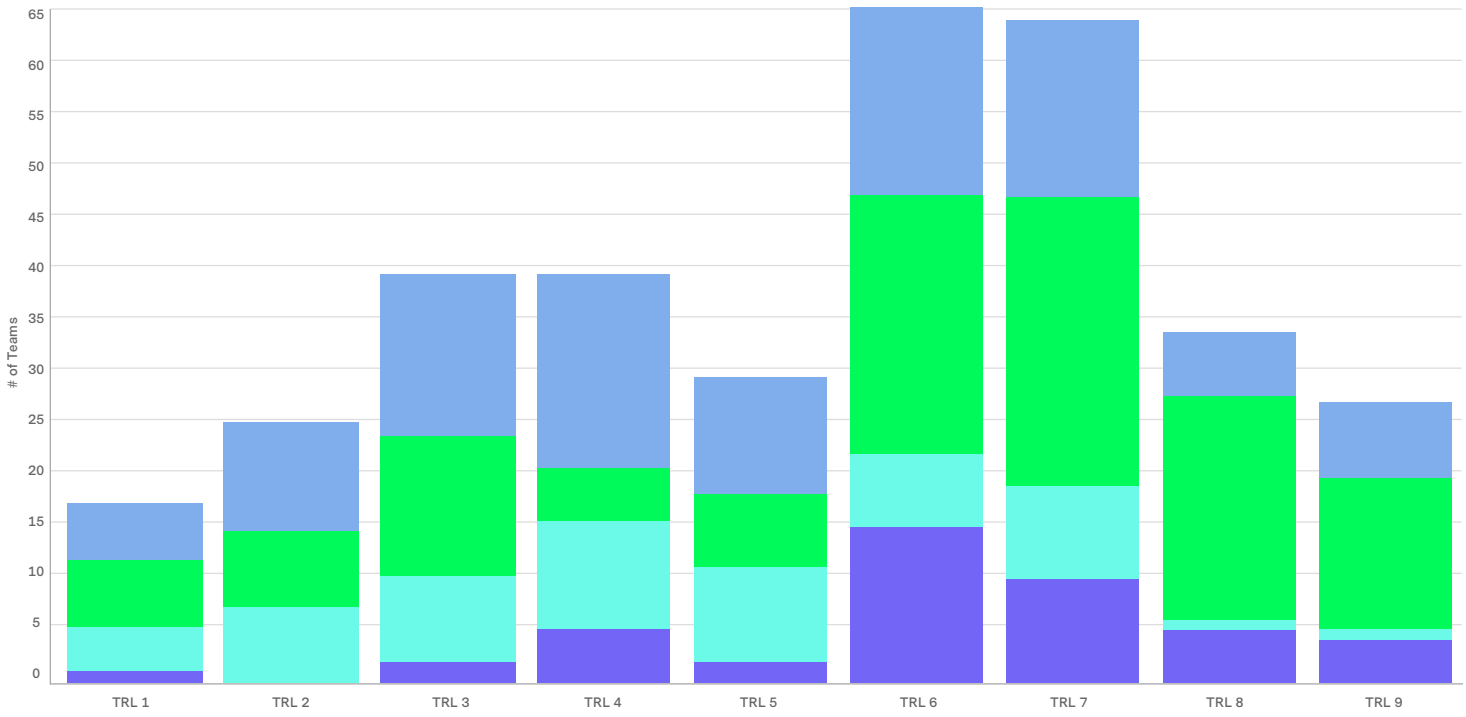
REMOVED TO DATE (Tonnes)	NUMBER OF TEAMS	CLAIMED CO_2 REMOVED TO DATE (Cumulative Tonnes)
0 - 100	212	25
101 - 500	63	7,859
501 - 10,000	40	142,245
10,001+	18	4,089,671

TECHNOLOGY READINESS

Technology Readiness Level (TRL) is a common framework used to benchmark the state of development of new technologies. The TRL scale ranges from 1 (Lab-level research of basic principles) to 9 (Commercially proven technology).[3]

XPRIZE has not mandated any specific technology readiness level for winning solutions, but the competition requirements imply a level of technical maturity: the key requirement of the final round of the competition is that the demonstrated CDR project must be complete in scope (encompassing both capture and sequestration) and it must be operating in the field (i.e. "relevant environment"). Systems or major subsystems need to be built, not modeled. Major subsystems should be, for the most part, integrated with one another to work together. While the system does not need to be fully commercialized, the performance must be such that it demonstrates overall net-negative performance. Together, these requirements suggest ideal candidates will be in the TRL range of 6 (Prototype validated in a relevant environment), 7 (System prototype validated in an operational system), or 8 (Actual technology successfully commissioned in an operational system), although demonstrations at lower or higher stages of development may win the prize, provided they meet the other competition requirements.

TECHNOLOGICAL READINESS LEVELS



[3] See Skone et. al 2022 for TRL definitions used by the US Department of Energy.

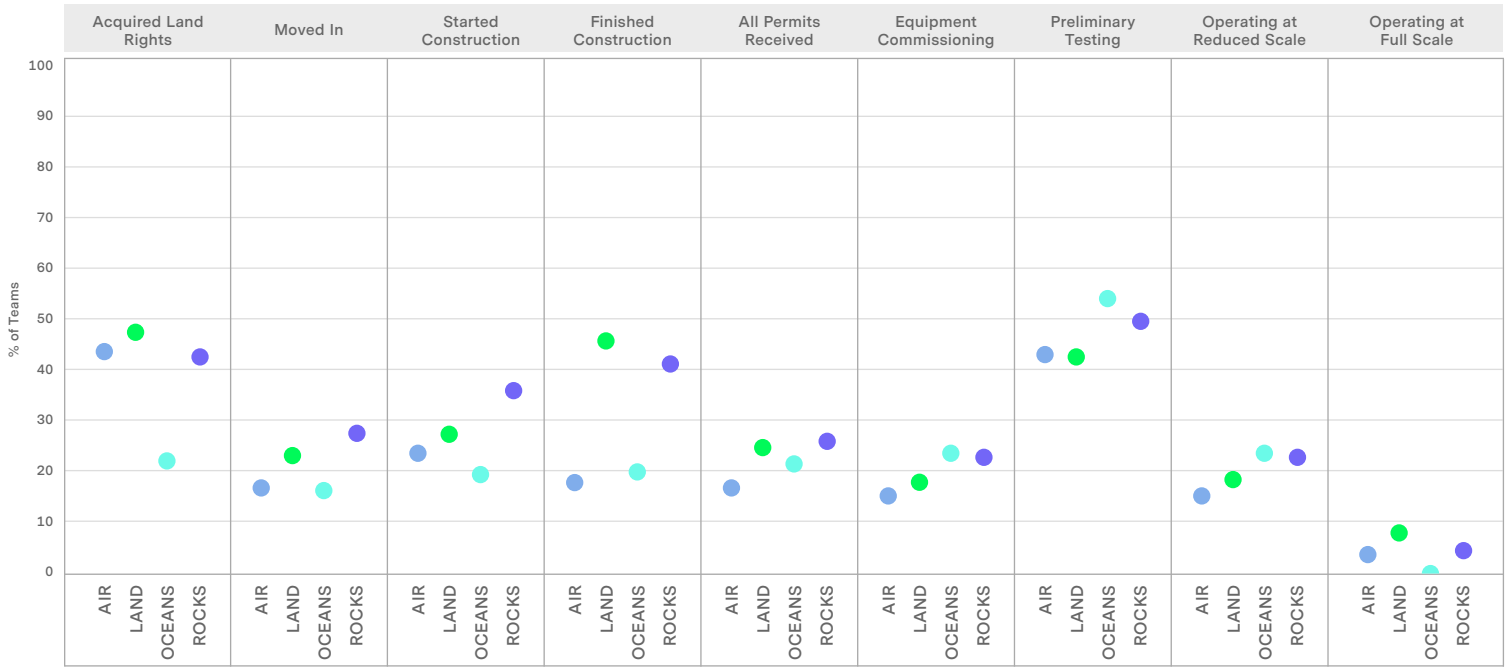
The data shows the majority of Teams self-report as TRL 6 and 7, although a broad range of levels are still represented in this cohort. Within each track, the median TRL values are listed below. These results suggest that while there are a variety of projects at all stages of development within each track, Oceans Teams are generally at the earlier stages, while Land and Rocks Teams are more advanced.

2023 MEDIAN TECHNOLOGY READINESS LEVEL (Self Reported)	
OCEANS	**TRL 4:** Basic technology components integrated and validated in a laboratory environment. System Simulation and Economic Analysis.
AIR	**TRL 5:** Basic technology components integrated and validated in a relevant environment. System Simulation and Economic Analysis Refinement.
LAND	**TRL 6:** Prototype Validated in Relevant Environment. Component integration is similar to the final application in most respects.
ROCKS	**TRL 6:** Prototype Validated in Relevant Environment. Component integration is similar to the final application in most respects.

STATUS OF OPERATIONS

Teams have made varying levels of progress against their goals to commission a working demonstration in 2024. While some are already operating at their intended scale, most are still in the design and development phases of their projects. Between 40-55% of Teams in each track are in the preliminary testing phase, and only 4-10% are operating at full scale. 46% of Teams in the Land track have finished construction compared to 41% in Rocks, 20% in Oceans, and 18% in Air. Between 15-28% of Teams across tracks have moved in to their intended demonstration site, and between 15-24% have commissioned equipment across tracks. Between 17-25% have received permits, leaving a large number of Teams still waiting on this critical step.

OPERATING STATUS BY TRACK (% OF TEAMS)



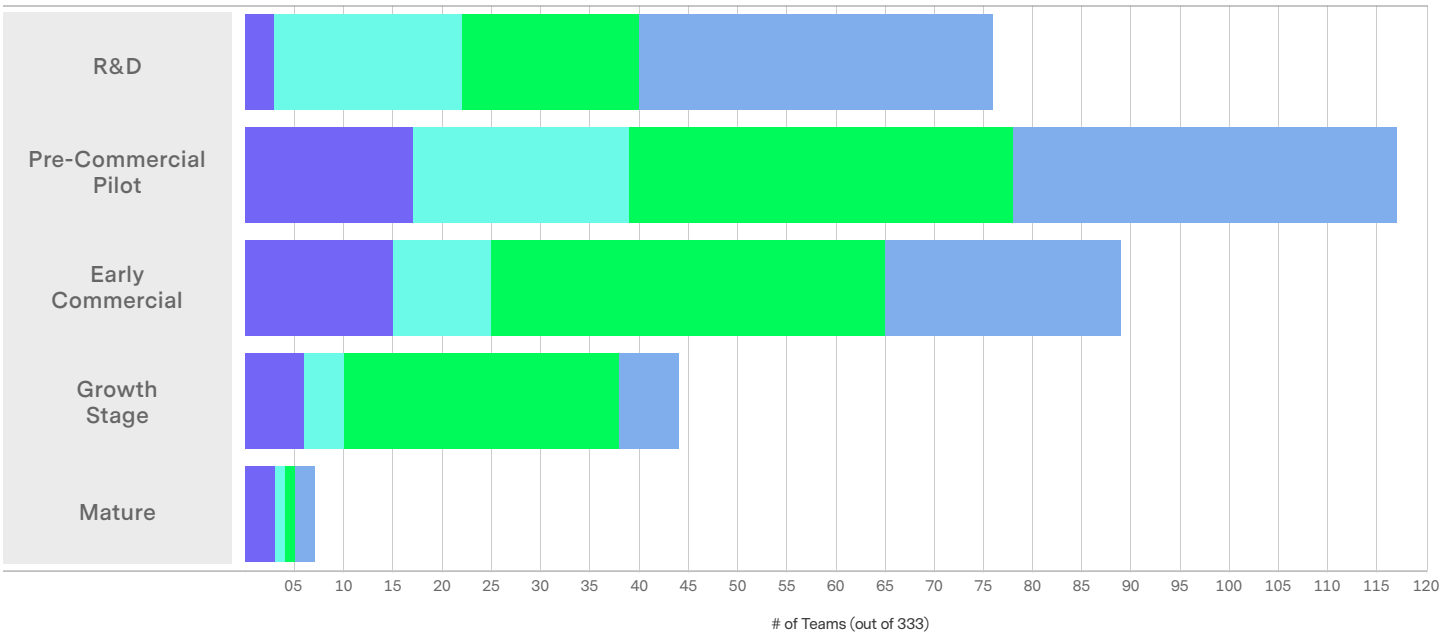
COMMERCIAL PROGRESS

XPRIZE CARBON REMOVAL

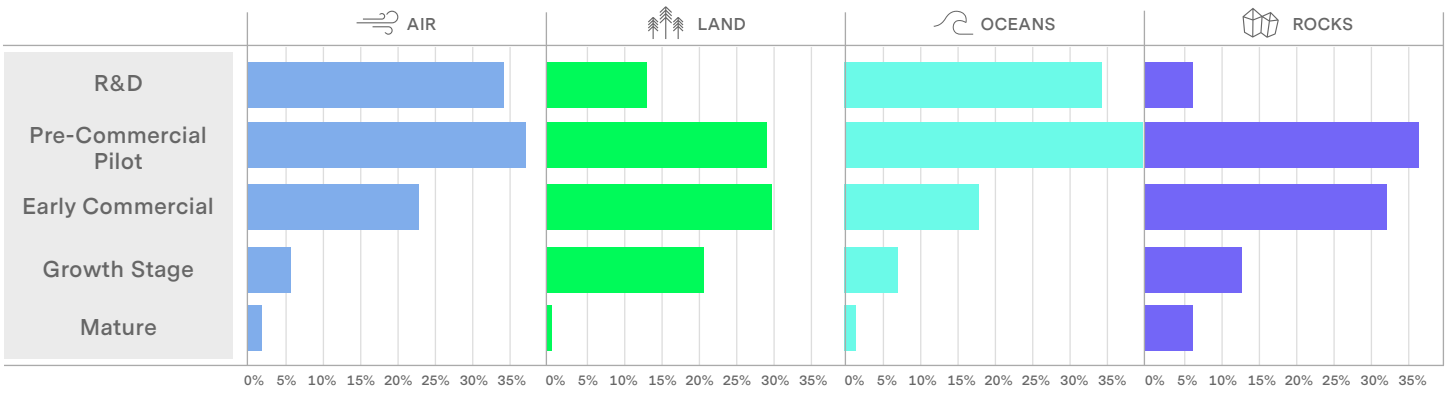
COMMERCIAL STAGE

Of the 333 Teams surveyed, the majority (58%) identify themselves as pre-commercial, focussing either on research & development (R&D) or deploying pre-commercial pilots. The next stage, early commercial demonstrations, is also strongly represented with 89 companies (27%). Air and Oceans Teams have the greatest focus on R&D (34% of Teams in each track). The Rocks track shows the highest percent of mature companies at 7%.

COMMERCIAL STAGE



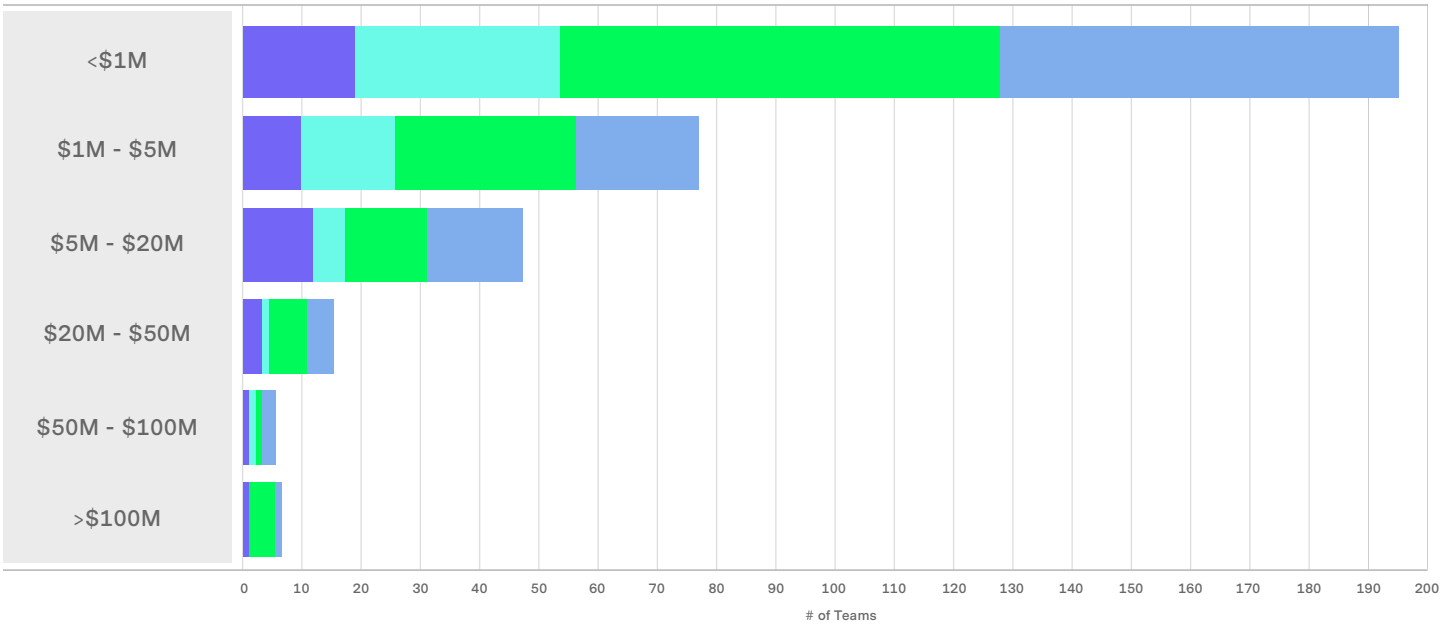
COMMERCIAL STAGE BY TRACK



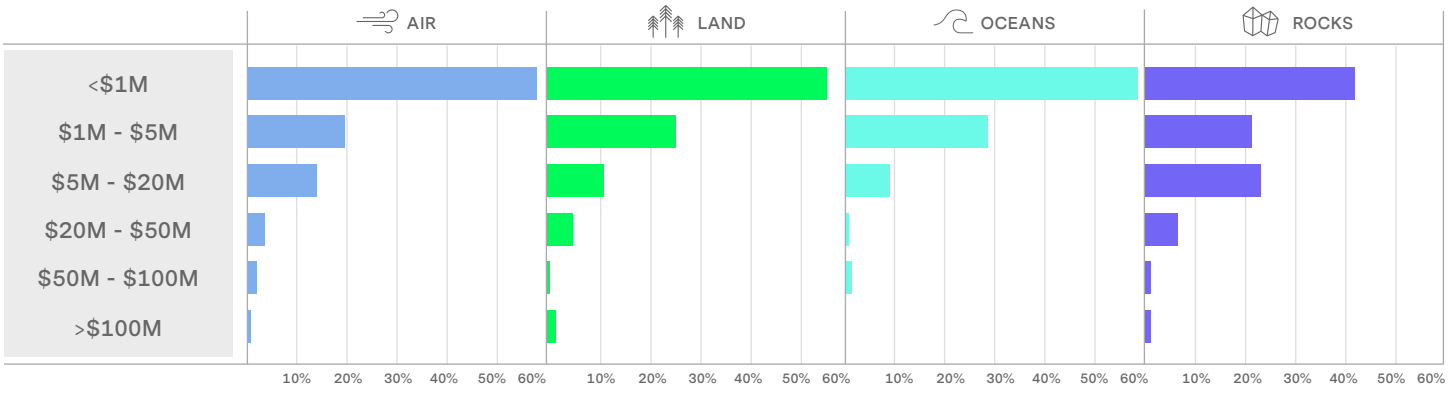
CAPITAL RAISED TO DATE

The majority of Teams surveyed (56%) have raised less than $1M USD, and only 3% have raised more than $50M. However, it is helpful to note that 77% of companies are actively fundraising. This is discussed in more detail on page 24.

CAPITAL RAISED



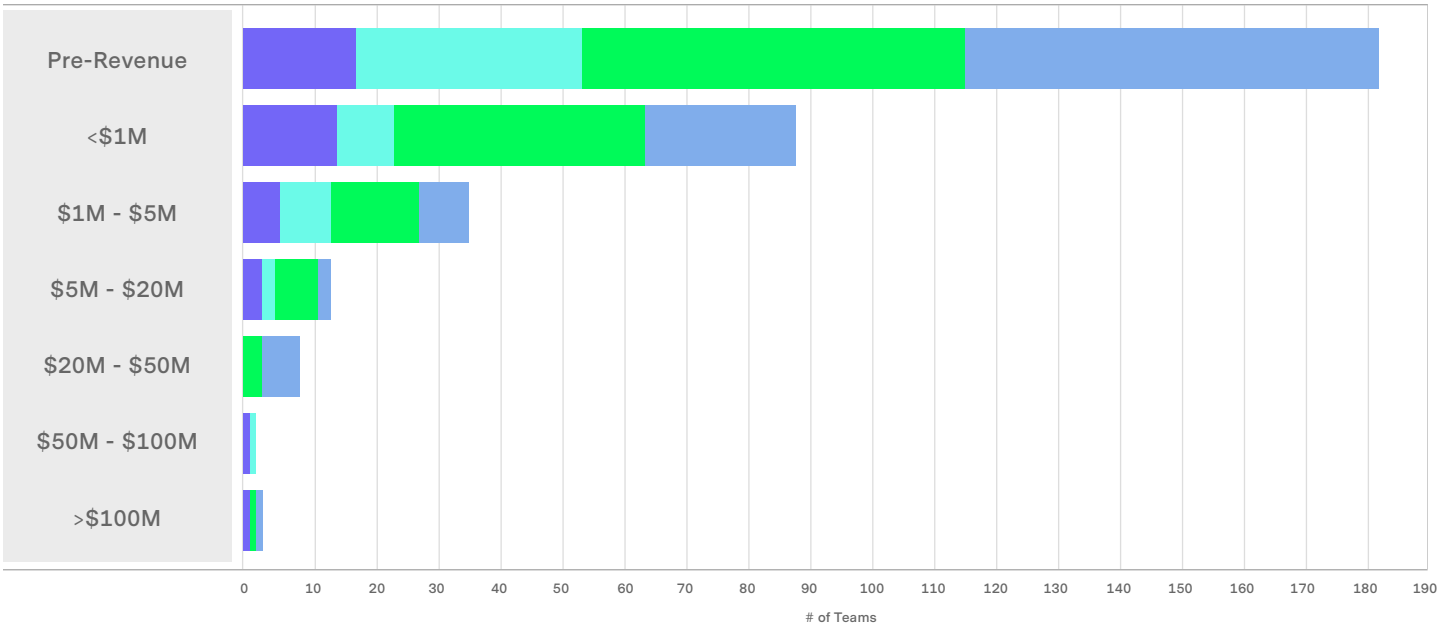
CAPITAL RAISED BY TRACK



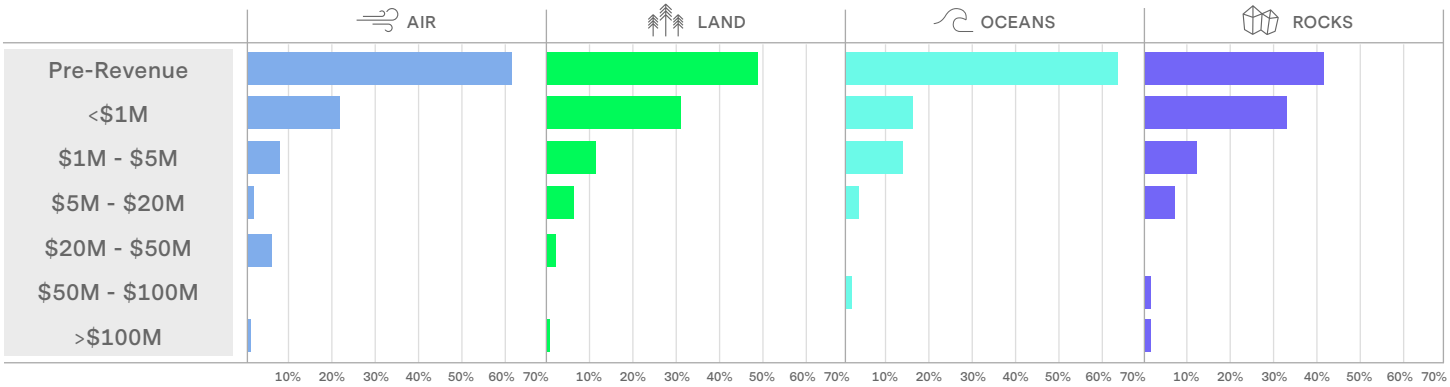
REVENUE

Overall, the majority of Teams (54%) indicated they are pre-revenue, however, the Land and Rocks Teams are slightly more mature from a revenue standpoint. Broadly speaking, the annual revenues reported by Teams are generally modest at this point in time, with only 25 Teams reporting revenues over $5M/year.

REVENUE



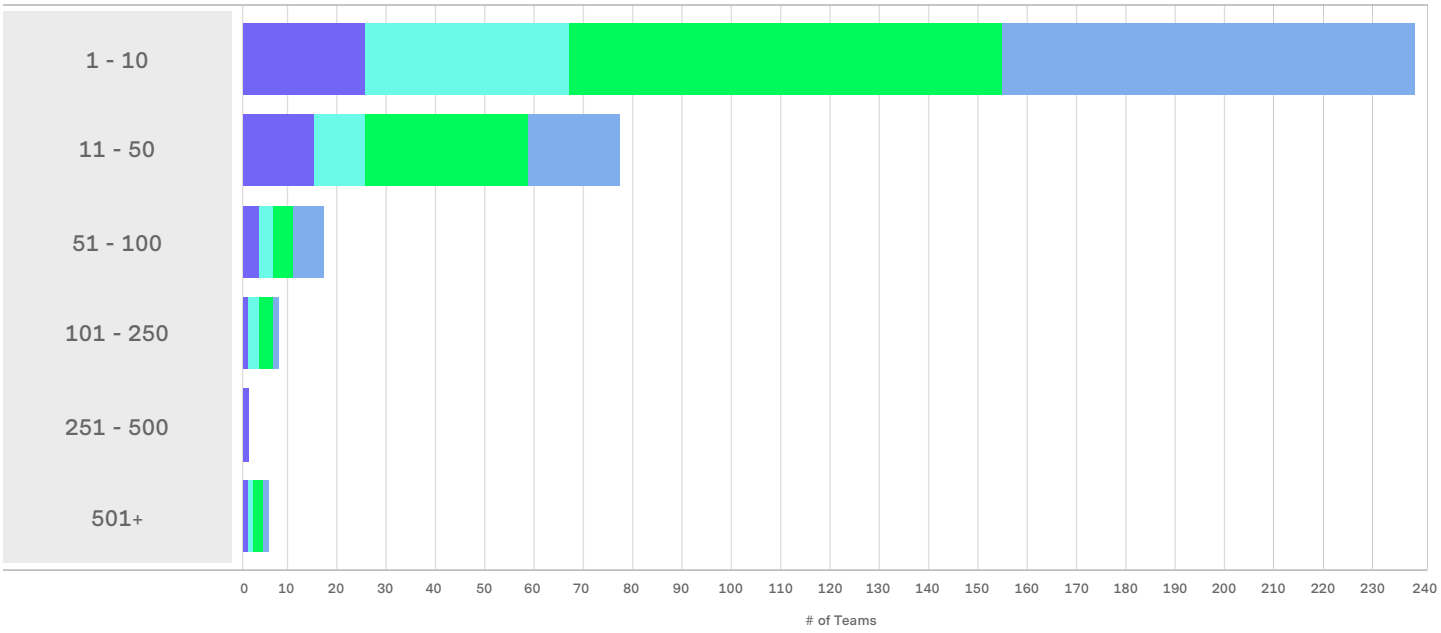
REVENUE BY TRACK



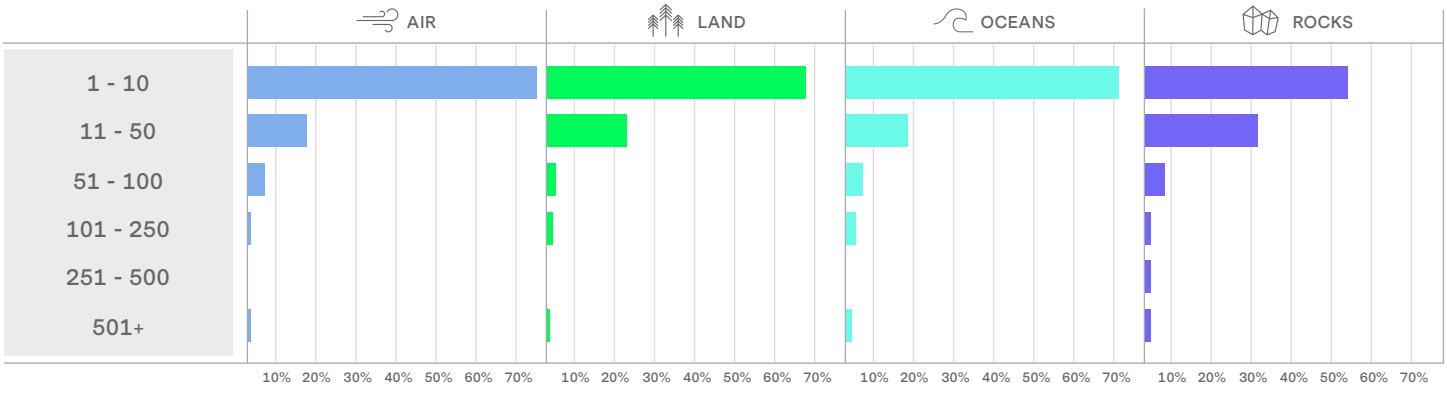
NUMBER OF EMPLOYEES

The vast majority of CDR companies (69%) are small businesses with fewer than 10 employees, and 22% have between 11-50 employees. However, there are a handful of larger enterprises (5) with more than 500 employees in the competition.

NUMBER OF EMPLOYEES



NUMBER OF EMPLOYEES BY TRACK

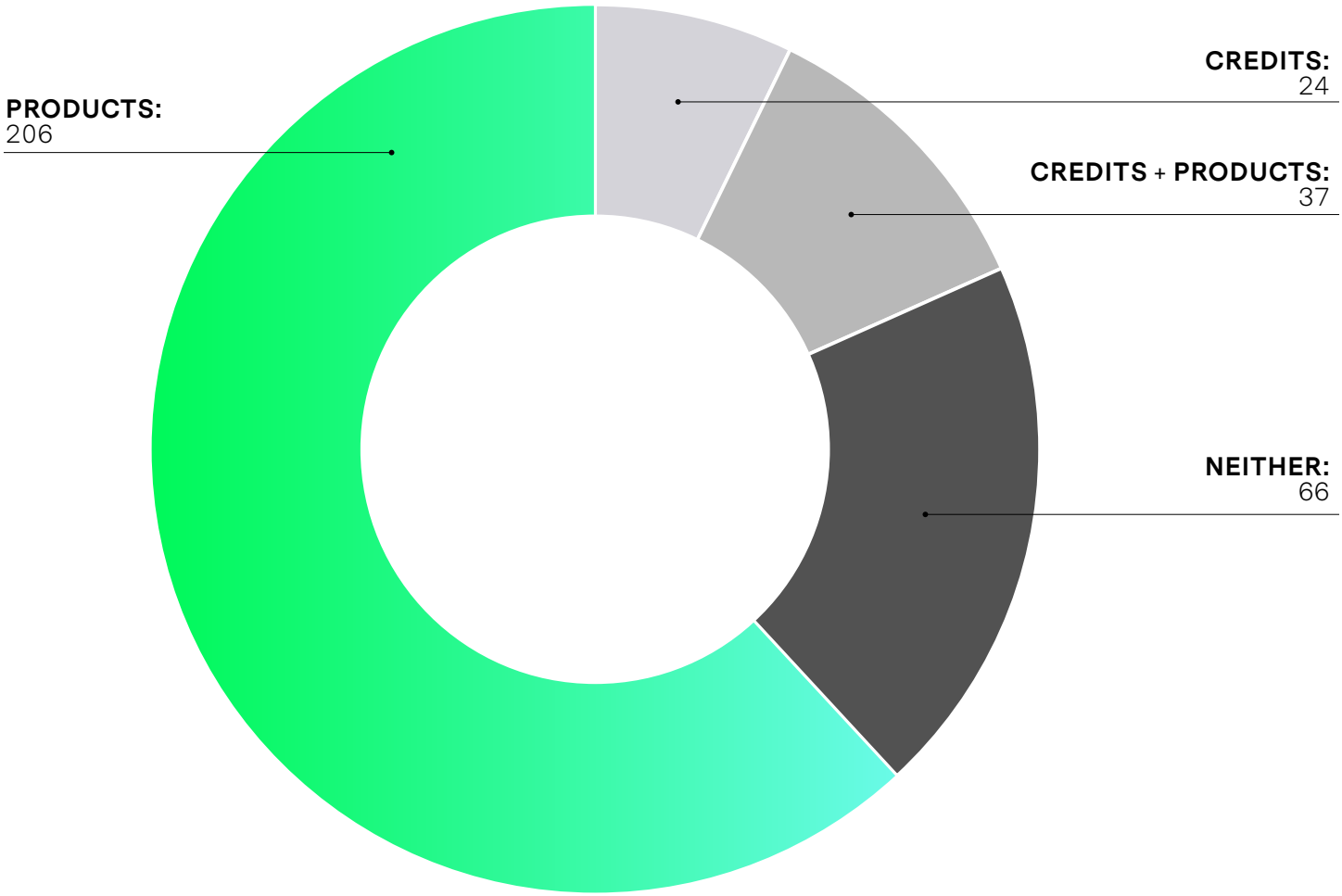


REVENUE MODELS

There are two primary revenue models to support carbon removal companies today: selling carbon removal credits and selling products.

The majority of Teams represented in this report are pre-revenue (54%), but we expect that most will eventually sell carbon credits. We also expect new business models to emerge moving forward, but for the time being we polled Teams on these two sources of revenue. Of the 333 active Teams, 61 (18%) have sold credits to date and 243 (73%) make products.

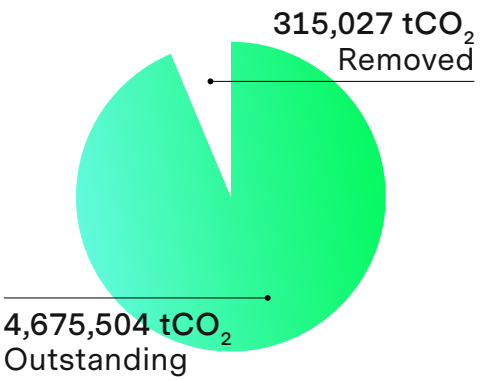
REVENUE MODELS



SELLING CREDITS

Together, the 61 Teams that have sold credits have sold 4,990,531 tonnes. To date, these teams have only removed 315,027 tonnes.

REMOVED VS. OUTSTANDING CREDITS SOLD

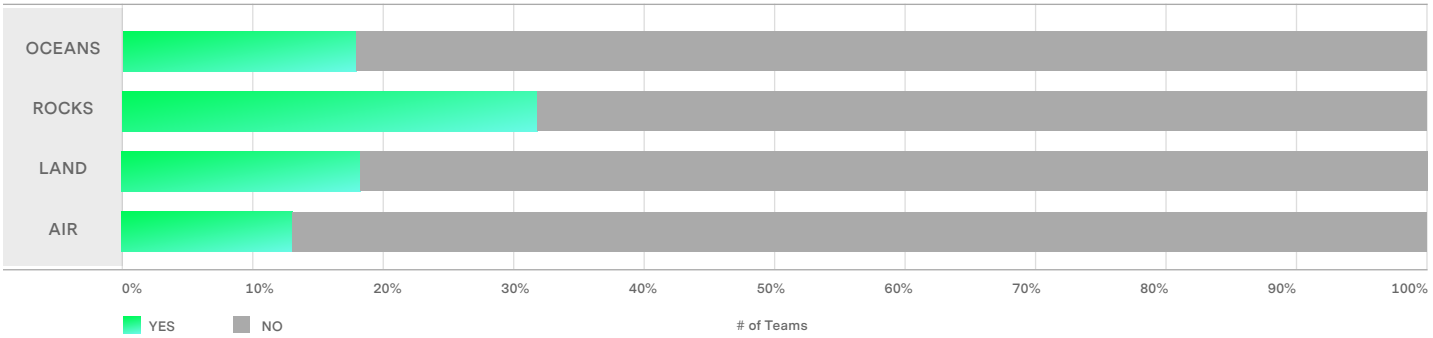


HAVE YOU SOLD CARBON CREDITS TO DATE?

	NUMBER OF TEAMS	TONNES SOLD TO DATE (Cumulative tonnes)	CLAIMED CO_2 REMOVED TO DATE (Cumulative tonnes)
YES	61	4,990,531	315,027
NO	272	-	3,924,736

Looking at credits sold by track to date, the Rocks track shows the highest percentage of projects selling credits at 32%, although that number only represents 14 projects because Rocks is the smallest track (44). By sheer volume, the Land track has a higher number of projects selling credits (23).

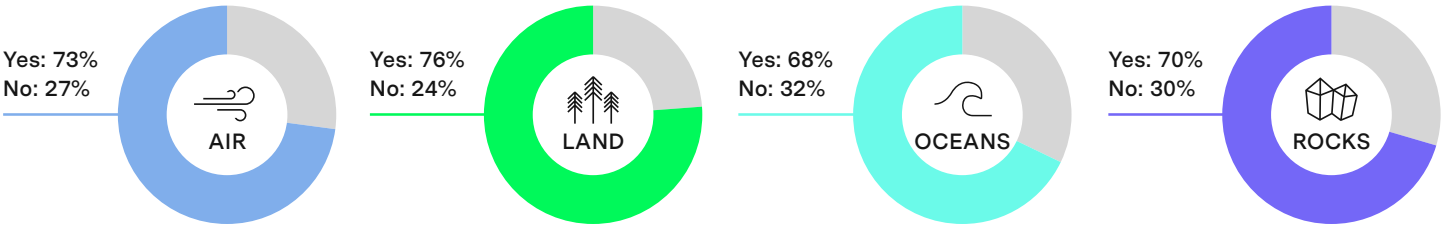
SOLD CARBON REMOVAL CREDITS (YES/NO)



SELLING PRODUCTS

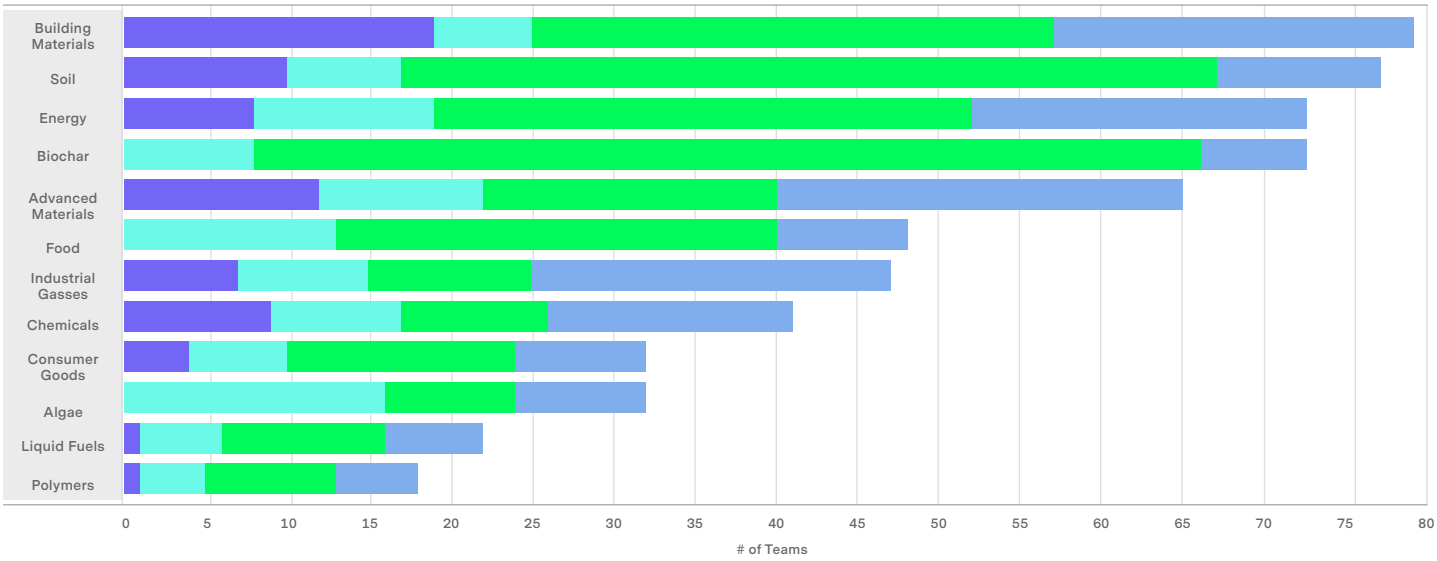
243 Teams (73%) reported that they are making products. The Land track has both the highest percentage of companies making products (76%) and the greatest number of Teams (96) making products of any track.

PRODUCTS BY TRACK



The top product categories represented across all tracks are building materials, soil, energy, and biochar. Note that some Teams are making multiple products, so those counts are reflected in the data.

PRODUCT CATEGORIES



The most popular products for each track are:

- Advanced Materials (25)
- Building Materials (22)
- Industrial Gasses (22)

- Biochar (58)
- Soil (50)
- Energy (33)

- Algae (16)
- Food (13)
- Energy (11)

- Building Materials (19)
- Advanced Materials (12)
- Soil (10)

INNOVATION LANDSCAPE

XPRIZE CARBON REMOVAL

INNOVATION LANDSCAPE

Carbon removal start-ups are innovating on a number of dimensions simultaneously. The top areas of innovation identified across the full cohort of 333 companies were:

52% Rapid Scalability

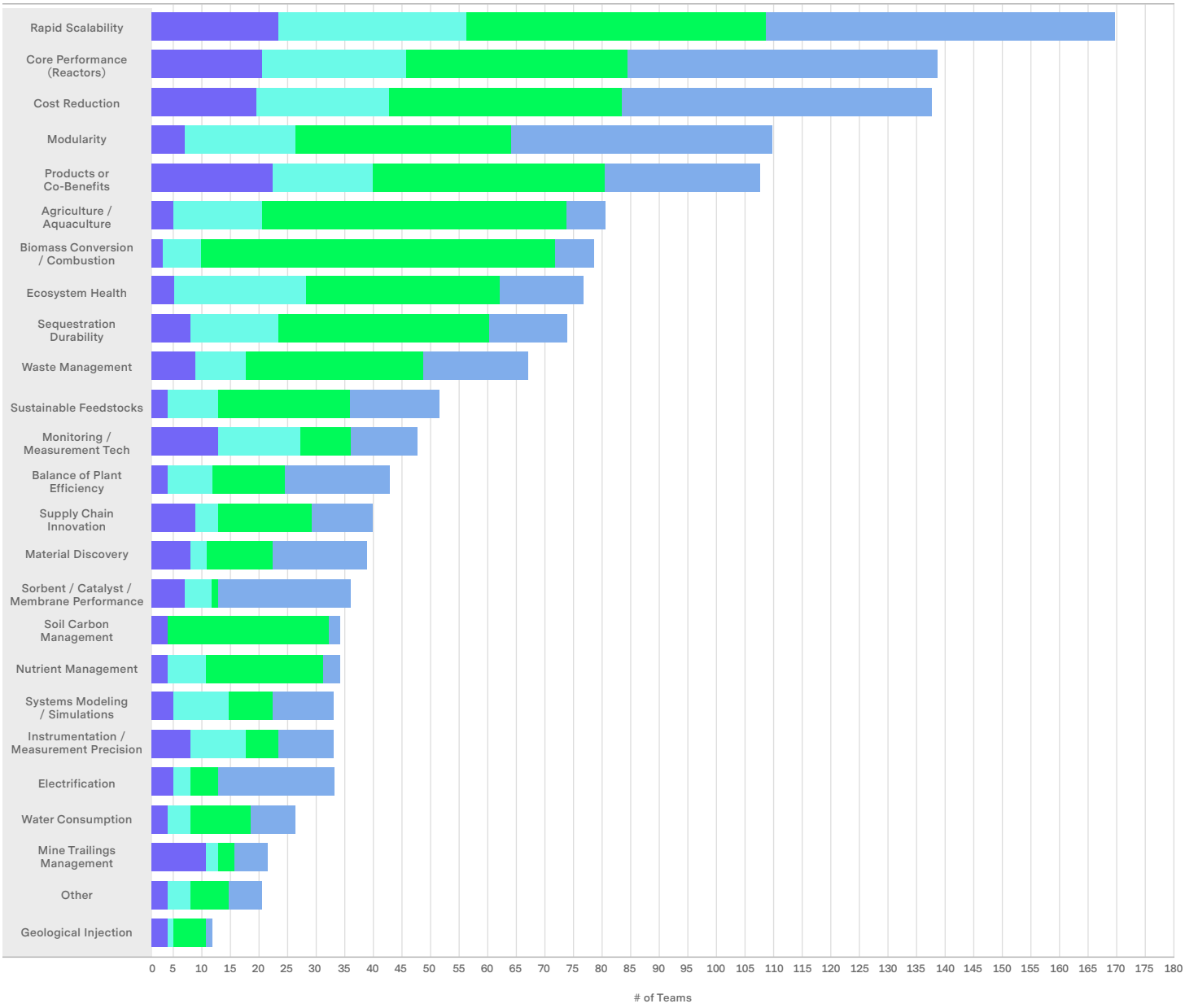
43% Core Performance

43% Cost Reduction

34% Modularity

33% Products or Co-Benefits

INNOVATION FOCUS



RAPID SCALABILITY

The climate crisis demands urgent action, so it is no surprise that 175 Teams reported that they are focused on rapid scalability. 55% of Teams TRL 6 and above reported this. For many Teams, the 1,000 tonne competition requirement represents a stretch goal. For more established types of removal (or more established companies), exceeding the goal will be possible. In either case, Teams are racing to scale up as quickly as possible.

CORE PERFORMANCE

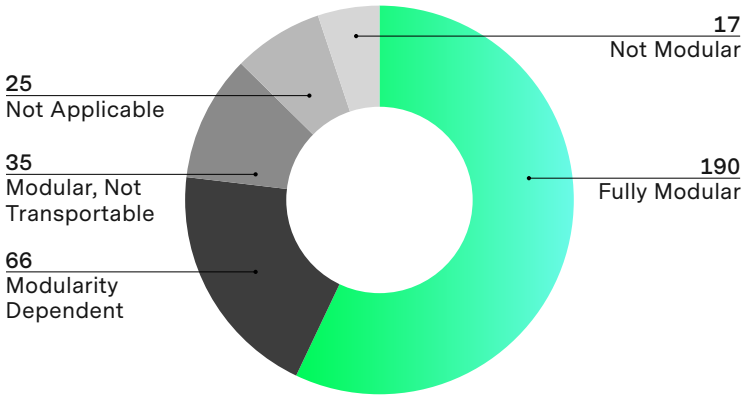
Core system performance is one of the most common areas of priority cited by teams (142 teams). This figure can be contrasted with the number of teams focussing on balance of plant efficiency (43 teams). As the CDR industry matures, we would expect the focus of teams to shift from core performance to balance of plant. Somewhat surprisingly, at this time, even teams reporting a technology readiness level of 9 do not report balance of plant efficiency as a priority.

COST REDUCTION

Low cost, high quality carbon dioxide removal is the holy grail, and will be critical to achieving gigatonne scale carbon removal globally. Cost is a key evaluation criteria in selecting the winner of XPRIZE Carbon Removal, and all Teams in the competition are required to model cost at projected megatonne scale. In addition to directly identifying cost reduction as an area of innovation, substantial numbers of teams indicate a priority on a longer list of items that are also significant drivers of cost including: energy use, water use, materials (including sorbent and catalyst development), feedstocks, plant efficiency, and core performance.

MODULARITY

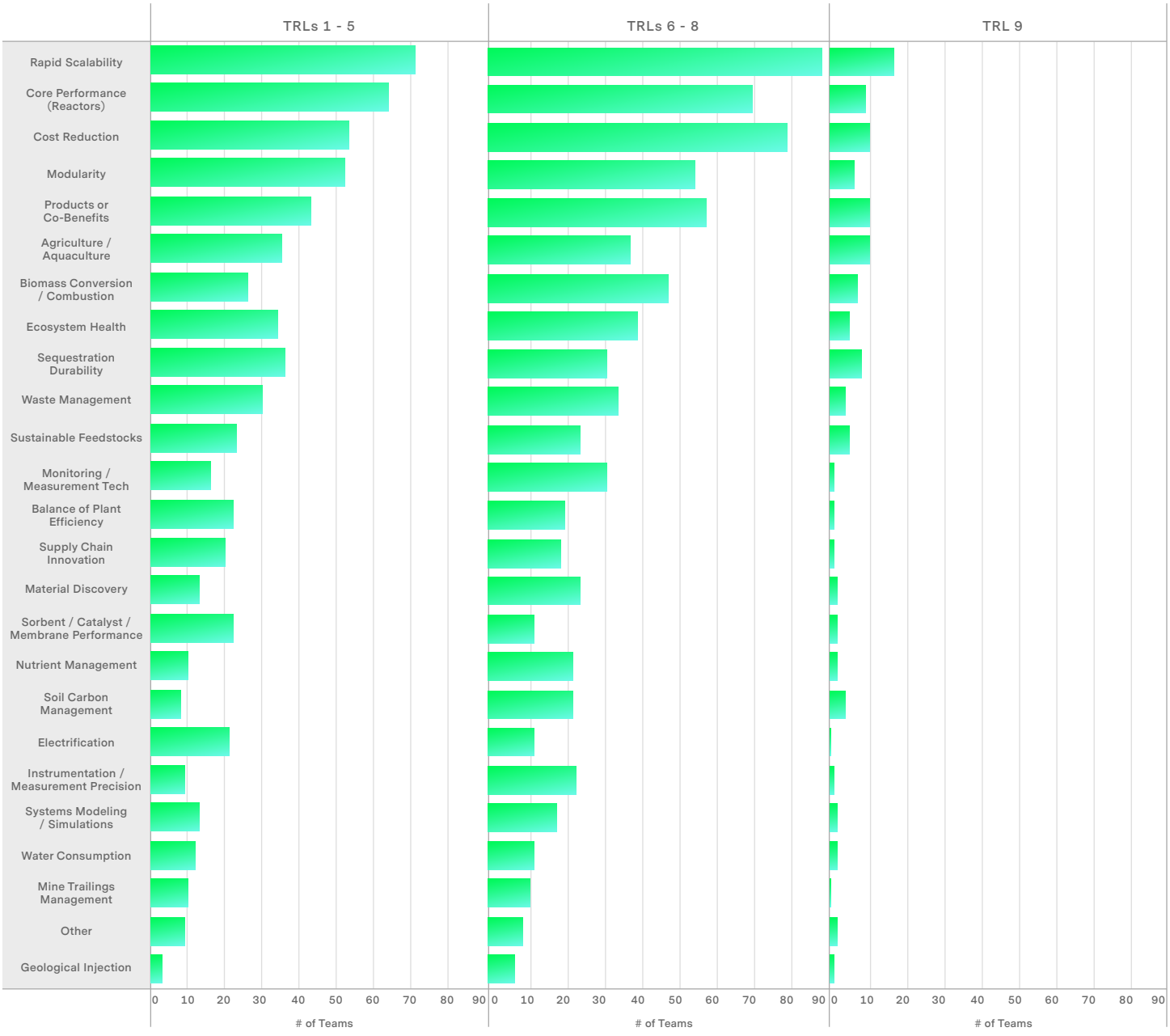
34% of teams reported they are innovating around the modularity of their systems. Broken down further, 57% (190) say their solution will be “fully modular and transportable”, 20% (66) say “modularity will be dependent on scale”, and 11% (35) will be “modular, not transportportable”.



AREA OF INNOVATION BY TECHNICAL MATURITY

As explained earlier, the target technology readiness level for the XPRIZE is between 6-8. The following breaks out the innovation priorities for those teams, as well as earlier stage and later stage efforts. We broke the data out further by TRL ranges, and interestingly, the top five areas of innovation remain fairly consistent across all ranges of technical development.

INNOVATION FOCUS TRL GROUP



CDR METHODOLOGIES

XPRIZE surveyed Teams on whether their projects follow existing published standards or methodologies. 33% of Teams referenced a formal standard or methodology, and 29 methodologies were referenced. The methodologies referenced include those from the major Carbon Offset and Carbon Removal registries (Puro.Earth, Verra, Gold Standard, etc) and proprietary standards commissioned by specific carbon removal teams (Carbfix, Planetary, Running Tide, etc.) - It is interesting to note that some of these "proprietary" methodologies are being adopted by other Teams. Teams who referenced standards include those who currently comply with the standard and those who anticipate future compliance with the referenced standard.

There are still a large percentage of teams who did not reference a formal methodology or standard. This is due to a number of factors: Some teams cited academic publications or patents rather than a carbon removal standard, and some explained that a proprietary methodology was pending. Many teams declined to share methodology data with us. In any case, this data suggests a strong need for further development and adoption of methodologies and standards.

TRACK	TEAMS Referencing a specific methodology or standard		TEAMS Not Referencing a specific methodology or standard	
AIR	61	15%	91	85%
LAND	62	49%	64	51%
OCEANS	15	27%	41	73%
ROCKS	16	36%	28	64%
TOTALS	109	33%	224	67%

The list of referenced methodologies and standards includes all references to published carbon management standards. References to an organization (eg. "Verra") or unspecific references (eg. "biochar standards") were not counted in this list.

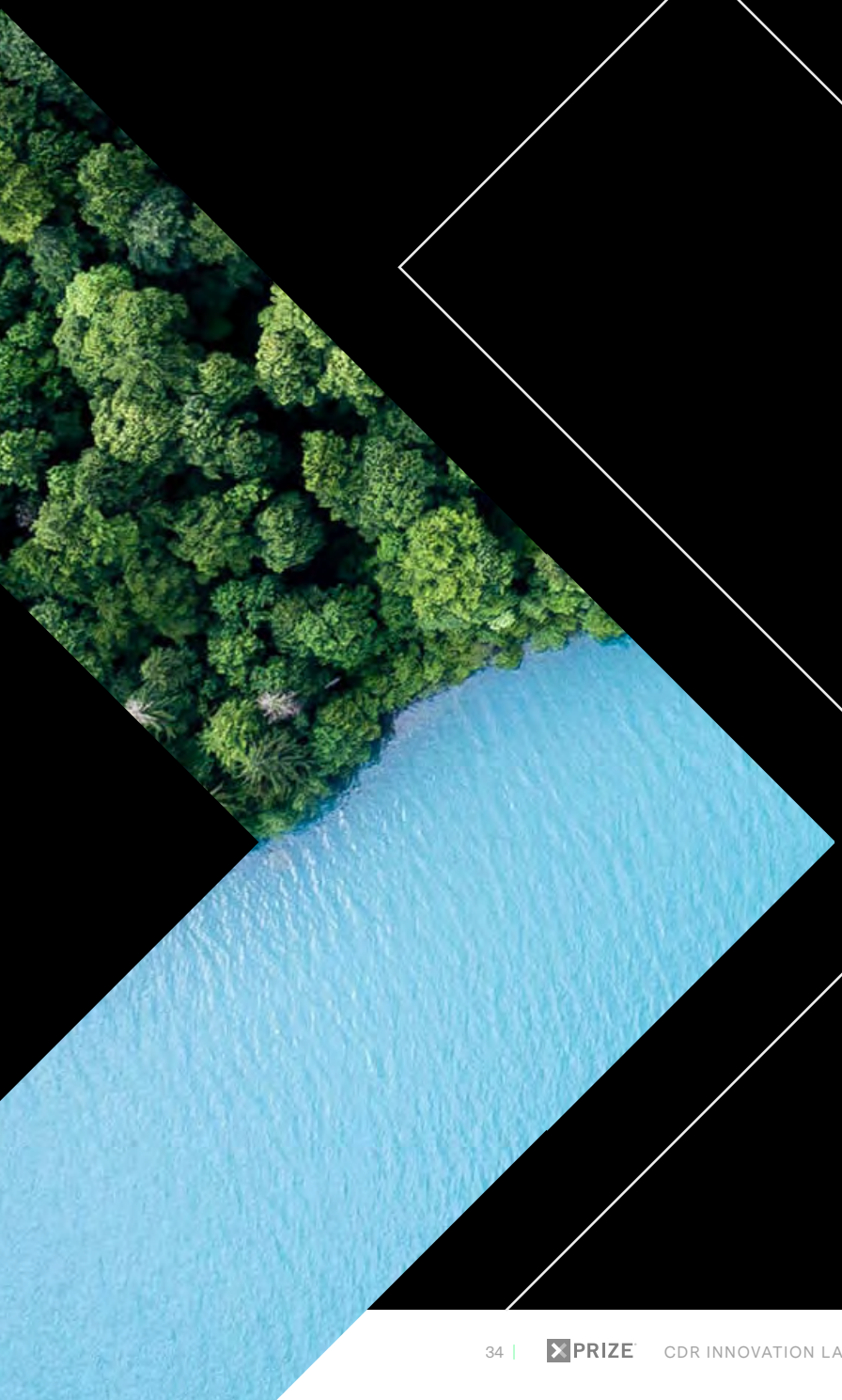
METHODOLOGY, PROTOCOL, or STANDARD	# OF TEAMS
European Biochar Certificate - Guidelines for the Certification of Biochar Based Carbon Sinks	22
Puro.earth Carbonated Materials	16
Puro.earth Biochar Methodology	15
ISO 14064 - Specification for quantification and reporting of greenhouse gas emissions and removals	14
Puro.earth Terrestrial Storage of Biomass / Woody Biomass Burial	9
Verra VCS Standard	7
International Biochar Initiative (IBI) Biochar Standards	6
Puro.earth Geologically Stored Carbon	6
Verra VM0042 Methodology for Improved Agricultural Land Management	5
Puro.earth Enhanced Rock Weathering	5
Carbfix Permanent And Secure Geological Storage Of Co2 By In-Situ Carbon Mineralization	5
Verra VM0043 Methodology for CO2 Utilization in Concrete Production	4
Gold Standard Carbon sequestration through accelerated carbonation of concrete aggregate	4
Carbon Standards International Guidelines for the Certification of Carbon Sinks created by Enhanced Rock Weathering in Croplands	4
Verra VM0044 Methodology for Biochar Utilization in Soil and Non-Soil Applications	3
Running Tide Framework protocol for multipathway biological and chemical carbon removal in the ocean	3
Climate Action Reserve US Forest Protocol	3
ISO 27913 - Carbon dioxide capture, transportation, and geological storage	2
Verra Methodology for Afforestation, Reforestation, and Revegetation Projects	2
Planetary Measurement, Reporting, and Verification (MRV) Protocol for OAE Carbon Removals	2
Andes Microbial Carbon Mineralization (MCM): Methodology for Quantification and Crediting of Carbon Dioxide Removal	2
Verra VM0017 Adoption of Sustainable Agricultural Land Management	1
Verra VM0033 Methodology for Tidal Wetland and Seagrass Restoration	1
Verra Enhanced Weathering	1
American Carbon Registry Afforestation and Reforestation of Degraded Land	1
American Carbon Registry Carbon Capture and Storage Projects	1
American Carbon Registry Methodology for Biochar Projects	1
Charm Bio-Oil Sequestration: Prototype Protocol for Measurement, Reporting, & Verification	1
Climate Action Reserve Climate Forward Reforestation methodology	1

The following table lists the pathways for which teams did not reference a specific standard or methodology. Higher numbers imply a greater need for development or adoption of methods and standards (and, in some cases, technological development):

PATHWAY	Not Referencing a Specific Methodology or Standard
Oceans - Nutrient fertilization	**100%**
Air - Solvent based direct air capture	**94%**
Land - Biological conversion of biomass (producing polymers, hydrocarbons for storage, etc.)	**89%**
Oceans - Microalgae cultivation (phytoplankton, etc.)	**89%**
Oceans - Artificial upwelling and downwelling	**89%**
Oceans - Electrochemical CO2 separation from seawater and/or water splitting	**88%**
Air - Membrane based direct air capture	**88%**
Air - Solid sorbent direct air capture	**83%**
Oceans - Ocean alkalinity enhancement	**81%**
Air - Electrochemical direct air capture	**79%**
Oceans - Macroalgae cultivation (seaweed, kelp cultivation, etc.)	**76%**
Rocks - In-situ mineralization (mafic or ultramafic mineralization, etc)	**75%**
Rocks - Calcination of minerals with CO2 capture	**75%**
Oceans - Ocean ecosystem restoration and management (seagrass, corals, mangroves etc.)	**73%**
Land - CO2 capture and storage from biogenic sources	**70%**
Oceans - Biomass sinking or ocean burial	**69%**
Rocks - In-situ storage in sedimentary reservoirs	**67%**
Land - Terrestrial ecosystem restoration and management (forests, peatlands, etc.)	**65%**
Rocks - Mineralization of mine or industrial waste	**65%**
Land - Biomass sequestration in the built environment	**61%**
Land - Agricultural & grassland CDR (crops, soils, etc.)	**60%**
Land - Biomass to energy (electricity or heat) with CO2 capture and storage	**60%**
Rocks - Ex-situ mineralization of mined rocks	**59%**
Land - Biomass direct burial	**58%**
Land - Thermal conversion of biomass (producing biochar, hydrocarbons for storage, etc.)	**41%**

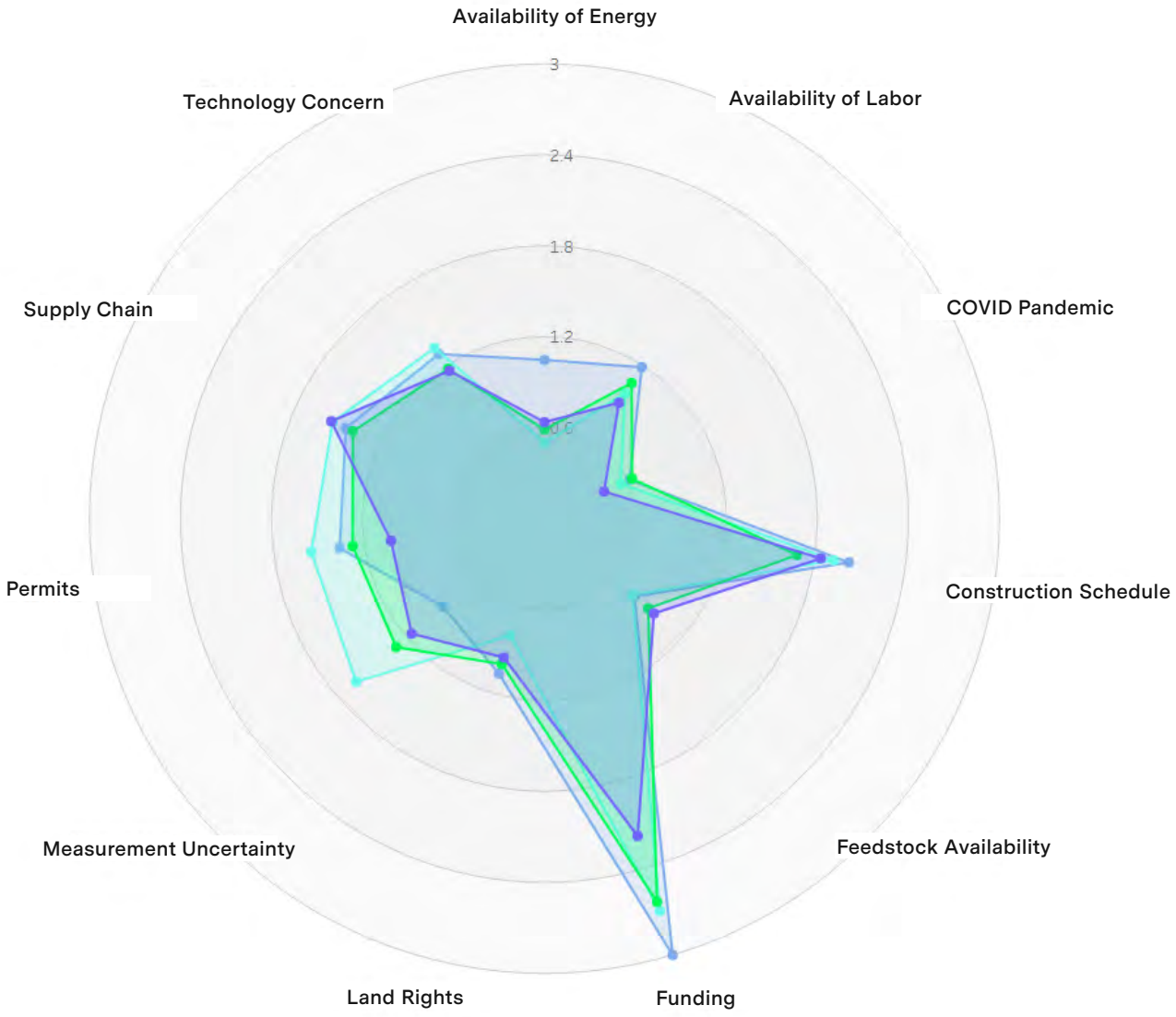
BARRIERS

XPRIZE CARBON REMOVAL



Teams were asked to report on the barriers and risks they are facing as they commission their CDR demonstrations.

These risks spanned a wide variety of potential challenges, from logistical complications like scheduling and supply chain issues, sector-related challenges like feedstock shortages and technological shortcomings, and legal complexities like land rights or permitting. XPRIZE is also sensitive to the complications that Teams have and will continue to face arising from the COVID-19 pandemic. Teams were asked to assess the level of risk each factor presented to the success of their CDR demonstration on a **scale of 0-5** (**0 = no risk, to 5 = acute risk**) . The visualizations below show averaged data by track.

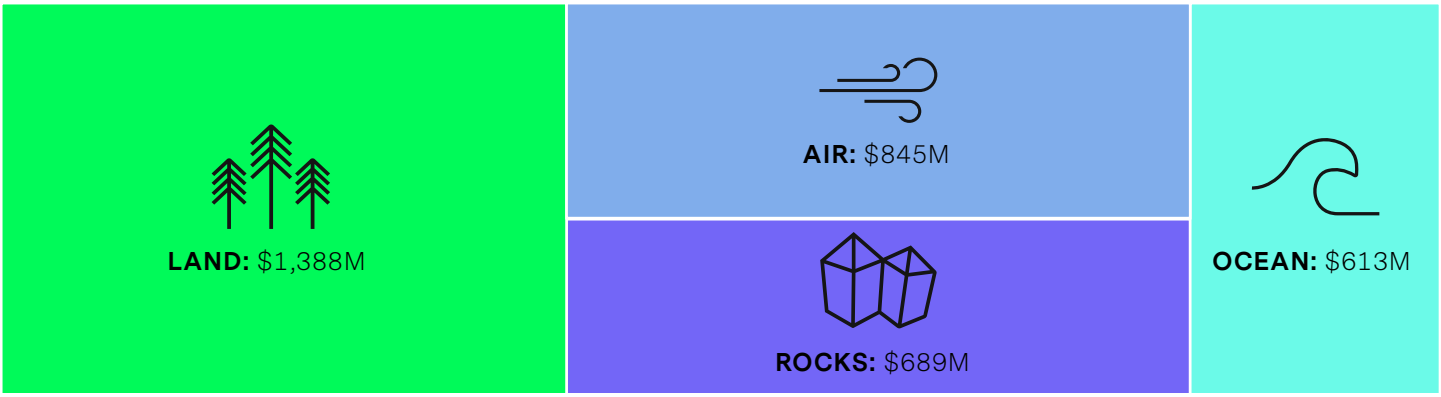


FUNDING

Funding was identified by Teams as the most significant risk across all four tracks, but was rated as most acute in the Air track, and least acute in the Rocks track. 256 out of 333 companies (77%) reported they are currently fundraising. **Collectively, Teams are seeking to raise over $3.5B USD.** The land track is currently raising the most, but they also have the highest number of projects (126). Of the companies currently fundraising, 42% (121) are raising between $0-2M, 37% (109) are raising between $2-10M, 12% (36) are raising between $10-30M, and 9% (25) are raising over $30M.

Additional data around fundraising trends, capital sought, and active deals is being tracked by the Circular Carbon Network, an initiative of XPRIZE, and can be found at circularcarbon.org.

AMOUNT OF CAPITAL SOUGHT



AMOUNT OF CAPITAL SOUGHT BY TRACK

MISSING KEY CAPABILITIES

Commissioning a carbon dioxide removal project requires significant financial, human, and physical resources. We surveyed Teams on their needs to help identify critical gaps across the CDR industry. The top 4 key missing capabilities identified across EVERY TRACK were:

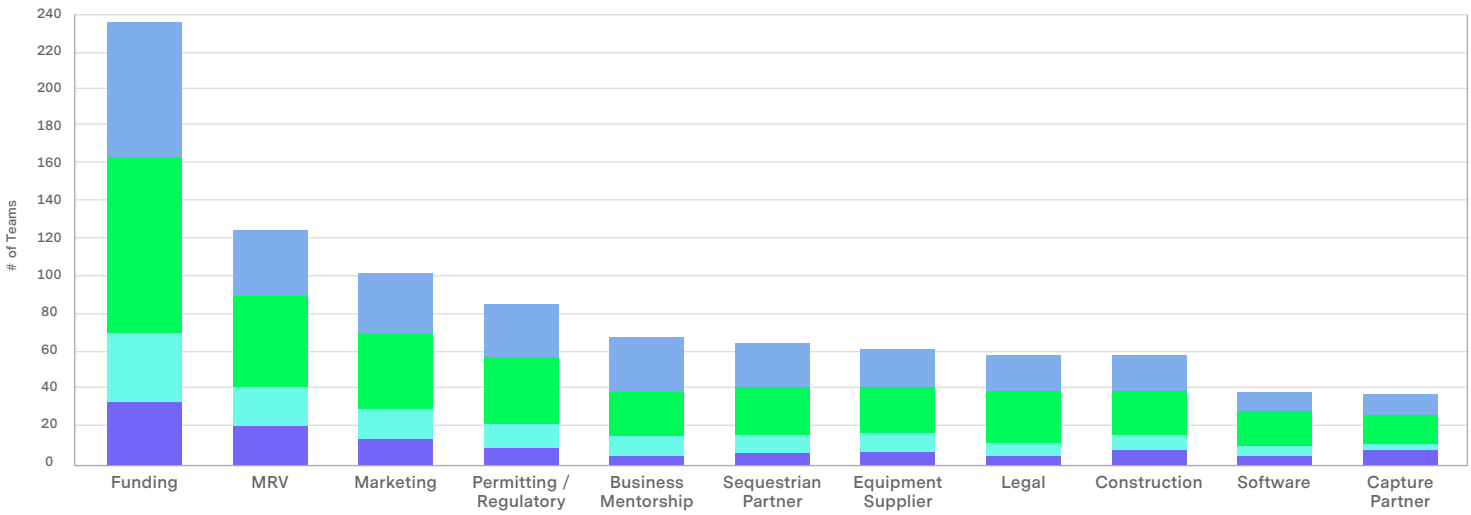
1. **FUNDING**
(236, 71% of Respondents)

2. **MRV**
(128, 38% of Respondents)

3. **MARKETING**
(105, 31% of Respondents)

4. **PERMITTING**
(86, 26% of Respondents)

MISSING KEY CAPABILITIES



MEASUREMENT, REPORTING & VERIFICATION (MRV)

Measurement, reporting, and verification (MRV) refers to the practice of, and requirements for, assuring that carbon dioxide removal is happening with the appropriate levels of quality and transparency. It can include verification of technology performance and ongoing monitoring requirements to ensure that removed CO_2 is sequestered reliably. MRV as a practice is mature in many industries (including traditional carbon offset markets), but there is not yet firm consensus on the MRV requirements within the CDR industry, and especially with regards to emerging solutions. While Teams may have the capability to measure their own progress, it is essential that the industry develops consensus around requirements, and develops the industry to independently evaluate carbon removal providers. While MRV was identified as a key barrier by Teams, relatively few Teams focus specifically on MRV (see Innovation Landscape chapter).

MARKETING

Climate communication has historically been a challenging area. It is an abstract concept that can be difficult to visualize and make relatable. Companies working on carbon removal solutions have the challenge of communicating with multiple stakeholder groups simultaneously who are new to this topic including: potential customers or buyers looking to meet their net zero goals, communities where their future projects may be located who may have experienced past harms from other extractive industries, as well as the general public who has likely never even heard of carbon removal or may carry fears of the unknowns it brings. So this will be an important function within all carbon removal companies moving forward, and an area where new talent will be needed from adjacent industries to help these companies develop their messaging strategies and reach new stakeholders as they scale.

PERMITTING

Permitting has been an important topic of conversation for carbon removal because at best, it holds the potential to cause significant project delays. At worst, it holds the potential to stop a project dead in its tracks. Teams will need to secure a wide range of permits depending on the carbon removal pathway, based on the location, scale, geology, etc. of their demonstration project. Permits play an important role in regulating the potential risk of new technologies for society, but can be burdensome for new companies as they require navigating complex bureaucratic systems and working closely with public agencies, which many Teams have never done before.

AIR SUMMARY

XPRIZE CARBON REMOVAL

AIR SUMMARY

Air-based CDR describes a class of technologies designed to remove CO_2 from the air.

The process typically involves using chemical reactions or filters to capture CO_2 from ambient, or outdoor, air. After the CO_2 is trapped, it can be stored using various carbon storage techniques or used for other purposes such as synthetic fuel production, carbon-negative materials, or enhanced plant growth. Teams competing in XPRIZE Carbon Removal must sequester their captured CO_2 with a durability of at least 100 years.

Teams developing Air based CDR demonstrations for XPRIZE Carbon Removal represent the following pathways:

Electrochemical direct air capture - Electricity is used to selectively separate CO_2 from the air, producing a pure stream.

Membrane based direct air capture - CO_2 is physically filtered from the air using membranes.

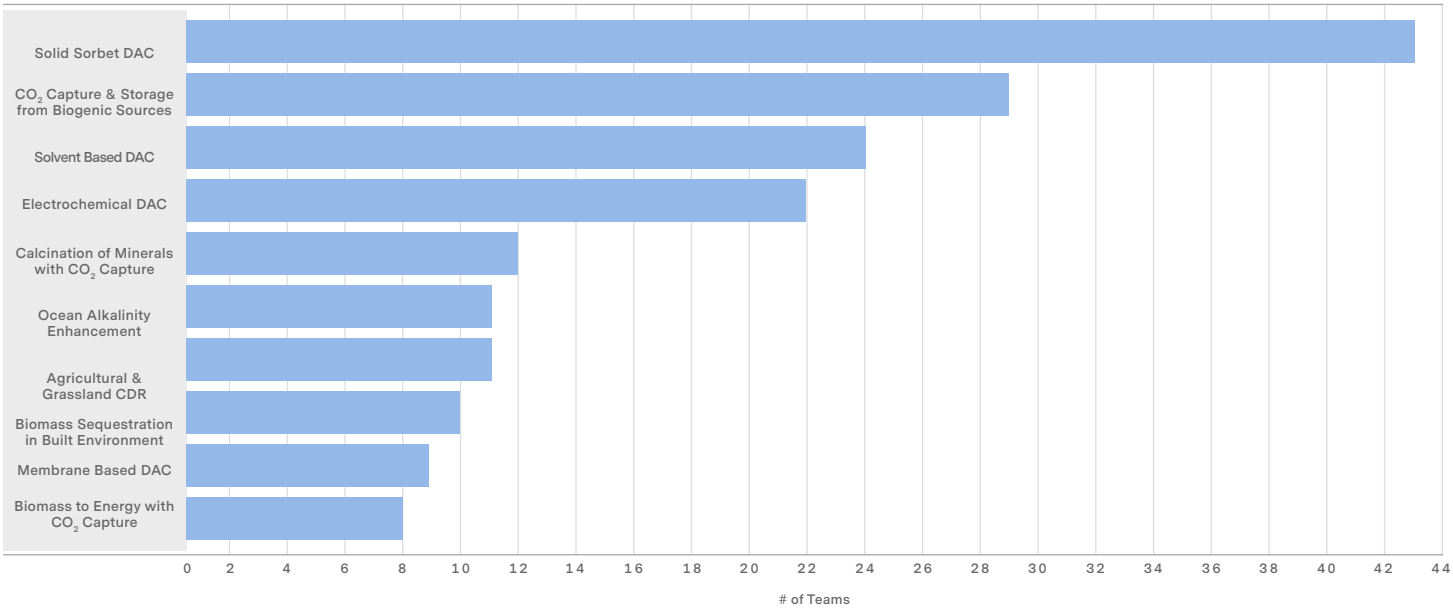
Solid sorbent direct air capture - Solid sorbents selectively capture CO_2 from the air during a "sorption" cycle, then the CO_2 is extracted in pure form during a "desorption" cycle.

Solvent based direct air capture - Solvents are pumped through a high-surface-area contactor where the solvent adsorbs CO_2 out of the air. The solvent can then be pumped into another process where the CO_2 is extracted, and the solvent is reused.

AIR SUMMARY

107 Teams selected Air as their primary track, and an additional 61 indicated Air as their secondary track. Those 168 Teams further indicated that they are working across the following pathways (multiple selections were allowed):

AIR TEAMS BY PATHWAY



Of the Teams who selected more than one Air pathway, the following represent the most common combinations of hybrid approaches:

13

- Solid sorbent direct air capture
- Solvent based direct air capture

11

- Electrochemical direct air capture
- Solid sorbent direct air capture

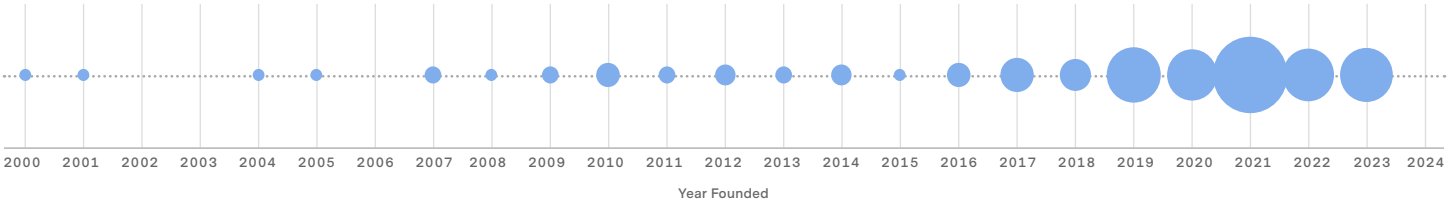
11

- Electrochemical direct air capture
- Solvent based direct air capture

GROWTH OF AIR-BASED CDR

Air-based CDR is a young field, with 51% of Teams (55 out of 107) having been founded since the 2021 and 76% since 2019 (86/107).

AIR TEAMS BY FOUNDING YEARS



TECHNICAL MATURITY OF AIR-BASED CDR

TRL by pathway for the Air track is quite distributed. Electrochemical DAC and membrane based DAC have the most Teams represented under TRL 3; Solvent based DAC, solid sorbent DAC and CO_2 capture & storage from biogenic sources have strong representation in the TRL 4-7 range. Very few Teams are at TRL 8 and a only a handful are at TRL 9 across all of the pathways.

AIR TEAMS BY TRLS

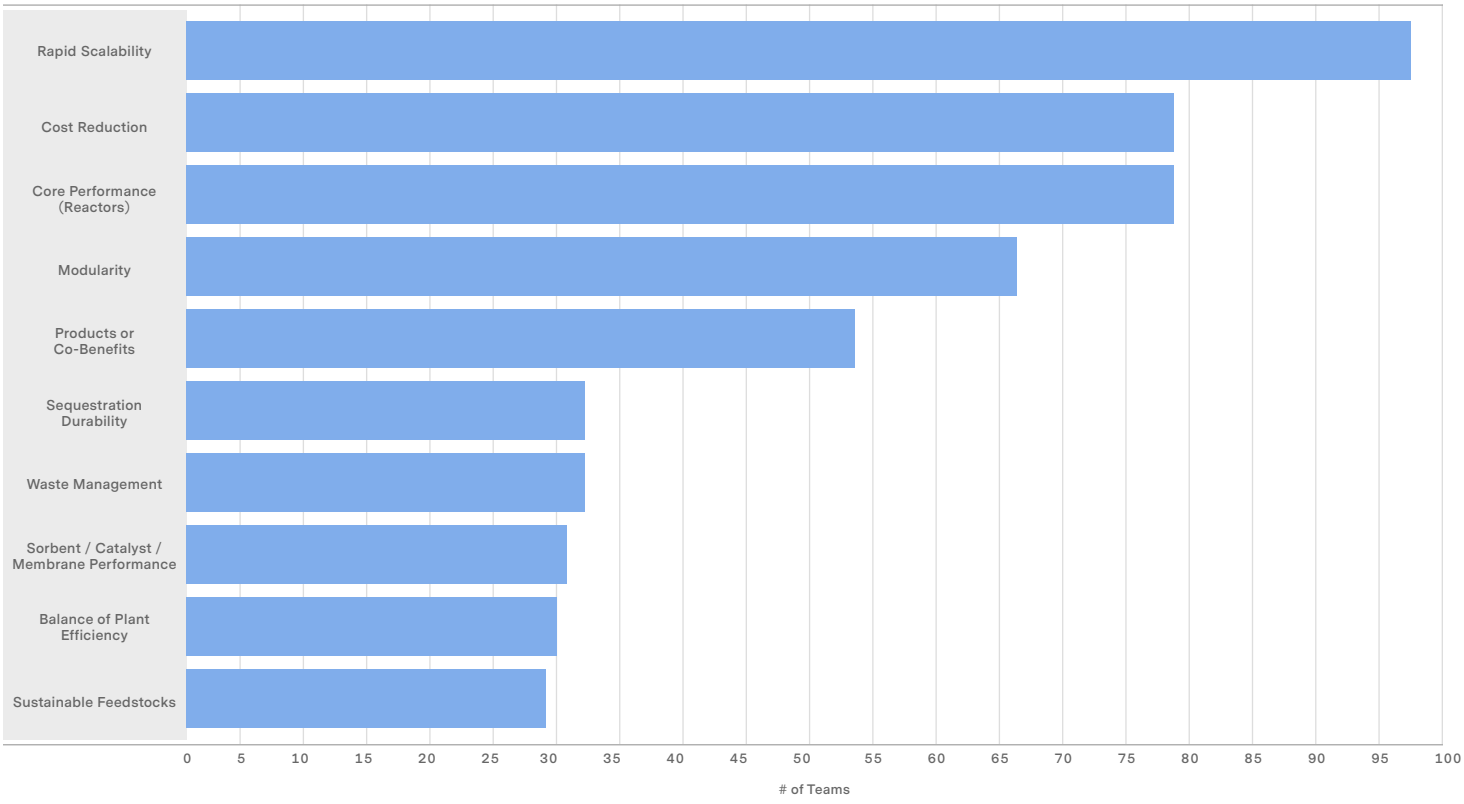
INNOVATION PRIORITIES

The most frequently cited priority areas for innovation for Teams working on air-based CDR include:

98	84	84	66	53
Rapid Scalability	Core Technology Performance	Cost Reduction	Modularity	Production of Products or Co-Benefits

Similar to the overall cohort, air-based Teams are focusing on scalability, cost reduction, core performance, modularity, and products. Additional areas of importance for this track include waste management, sequestration durability, sorbent/catalyst/membrane performance, and balance of plant efficiency.

AIR TEAMS BY INNOVATION FOCUS



HYBRID APPROACHES & COLLABORATION ACROSS TRACKS

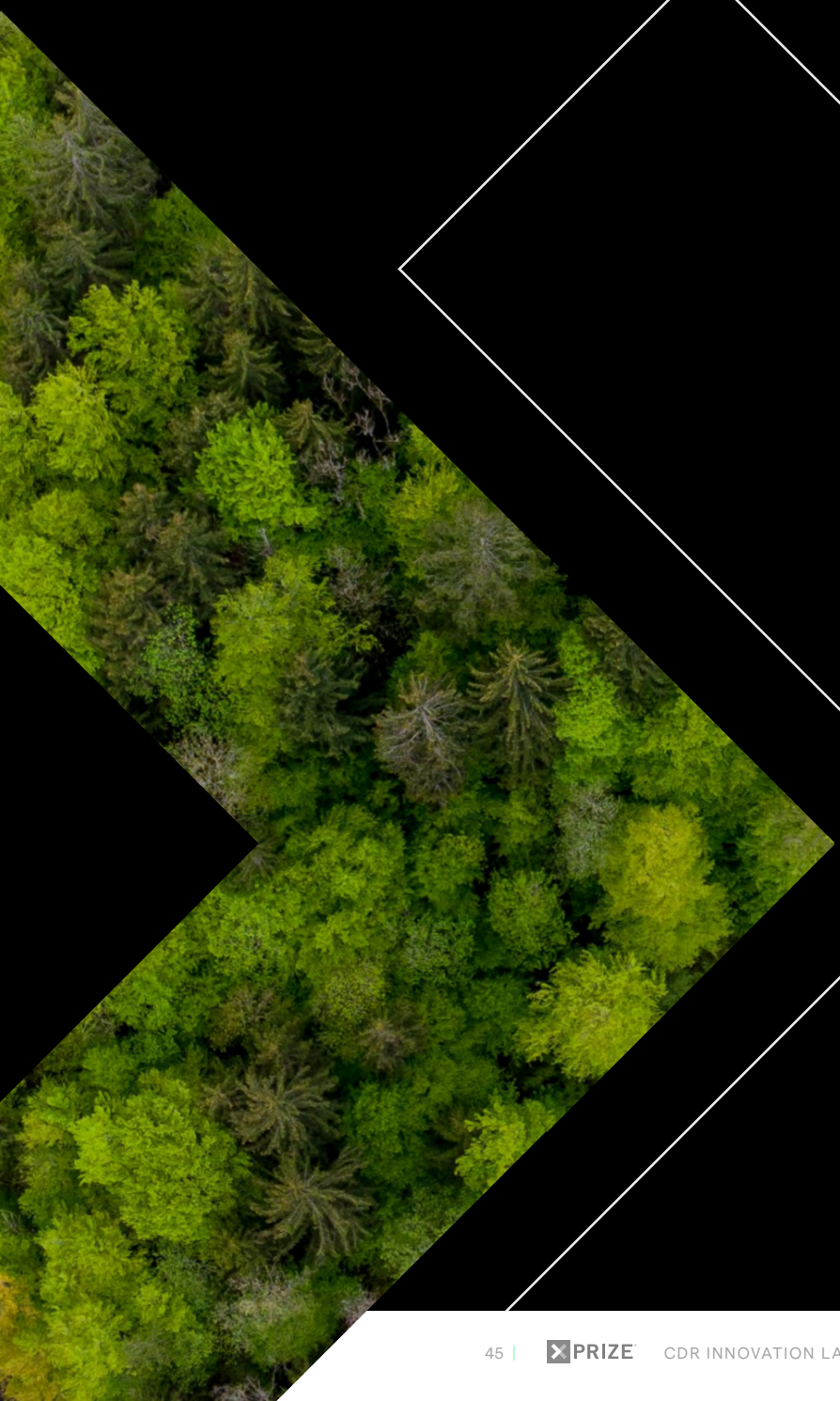
Of the 107 Teams who indicated “Air CDR” as their primary track, 64% indicated a secondary track of Land (25), Oceans (21), or Rocks (22):

25	21	22
Collaborations with “Land” Approaches	**Collaborations with “Oceans” Approaches**	**Collaborations with “Rocks” Approaches**

Of the air-based CDR Teams who indicated a hybrid approach with other tracks, the most common hybrid approaches were as follows:

Air - Solid sorbent direct air capture **Rocks -** Mineralization of mine or industrial waste	16
Air - Solid sorbent direct air capture **Land -** CO_2 capture and storage from biogenic sources	13
Air - Solid sorbent direct air capture **Rocks -** Calcination of minerals with CO_2 capture	11
Air - Solvent based direct air capture **Rocks -** Mineralization of mine or industrial waste	10
Air - Electrochemical direct air capture **Land -** CO_2 capture and storage from biogenic sources	10

LAND SUMMARY



LAND SUMMARY

Plants are an effective way to efficiently capture CO_2 from the atmosphere by leveraging photosynthesis.

Further, biomass can provide an effective vector for sequestering CO_2 durably in standing biomass and soils, or by converting biomass into another form (energy, durable products, bio-oil, etc) to facilitate durable sequestration. Land-based CDR developers can also leverage the infrastructure and practices of existing industries (agriculture, energy, forestry, etc) to boost their rate of deployment. Teams competing in XPRIZE Carbon Removal must sequester their captured CO2 with a durability of at least 100 years.

Teams developing land-based CDR demonstrations for the XPRIZE Carbon Removal represent the following pathways:

Agricultural & grassland CDR - Utilizing crops as a means of CO_2 capture, and soil as a means of sequestering CO_2.

Biological conversion of biomass - A number of products can be produced from biomass using biological processes like fermentation and anaerobic digestion.

Biomass direct burial - Sequestering biomass directly underground, ensuring that future emissions of CO_2 and other greenhouse gases generated by decomposition are not released.

Biomass sequestration in the built environment - Bio-based construction materials can effectively sequester CO_2 in buildings and other structures.

Biomass to energy - Coupling biomass fueled electricity or heat generation with CO_2 capture and storage.

CO2 capture and storage from biogenic sources - Photosynthesis is used to capture CO2 in the form of plant matter (biomass). Pure CO2 can be extracted from the biomass.

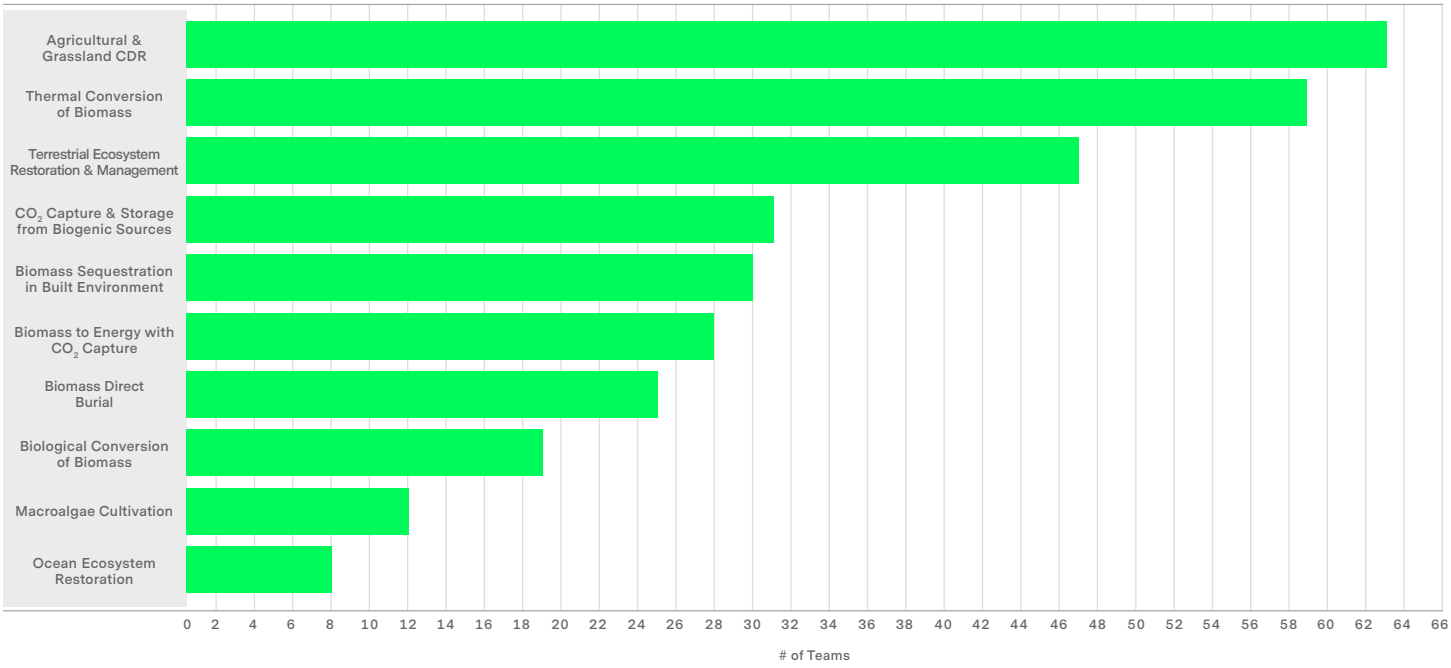
Terrestrial ecosystem restoration and management - Restoring and maintaining standing carbon stocks like forests, peatlands, wetlands, etc.

Thermal conversion of biomass - This includes the production of biochar, bio-gas and bio-oil for storage.

LAND SUMMARY

126 Teams selected Land as their primary track, and an additional 46 indicated Land as their secondary track. Those 172 Teams further indicated that they are working across the following pathways (multiple selections were allowed):

LAND TEAMS BY PATHWAY



Of the Teams who selected more than one Land pathway, the following represent the most common combinations of hybrid approaches:

35

- Agricultural & grassland CDR
- Terrestrial ecosystem restoration and management

28

- Agricultural & grassland CDR
- Thermal conversion of biomass

25

- CO_2 capture and storage from biogenic sources
- Terrestrial ecosystem restoration and management

23

- Biomass to energy with CO2 capture and storage
- Thermal conversion of biomass

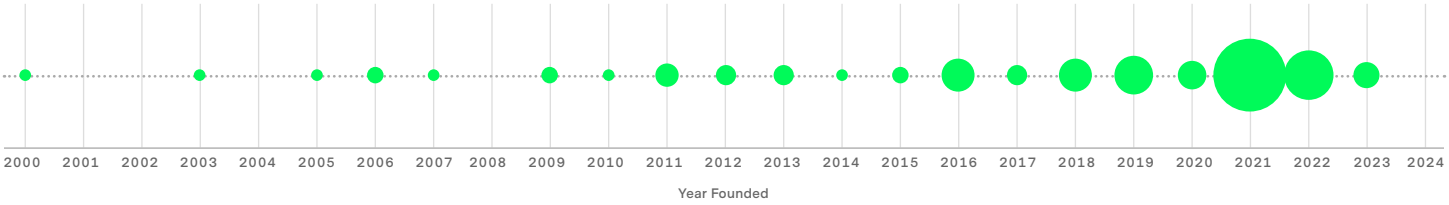
20

- Biomass sequestration in the built environment
- Agricultural & grassland CDR

GROWTH OF LAND-BASED CDR

Land-based carbon management is a mature field, but a focus on net-negative carbon dioxide removal is more recent, with a surge of interest since 2021.

LAND TEAM BY FOUNDING YEARS



TECHNICAL MATURITY OF LAND-BASED CDR

While many Land-based CDR Teams (33%) indicate a high level of maturity, with a technology readiness level of 7 or greater, there is a healthy pipeline of earlier stage innovators working in the field: approximately 30% of Teams indicate a technology readiness level of 3 or less.

LAND TEAMS BY TRLS

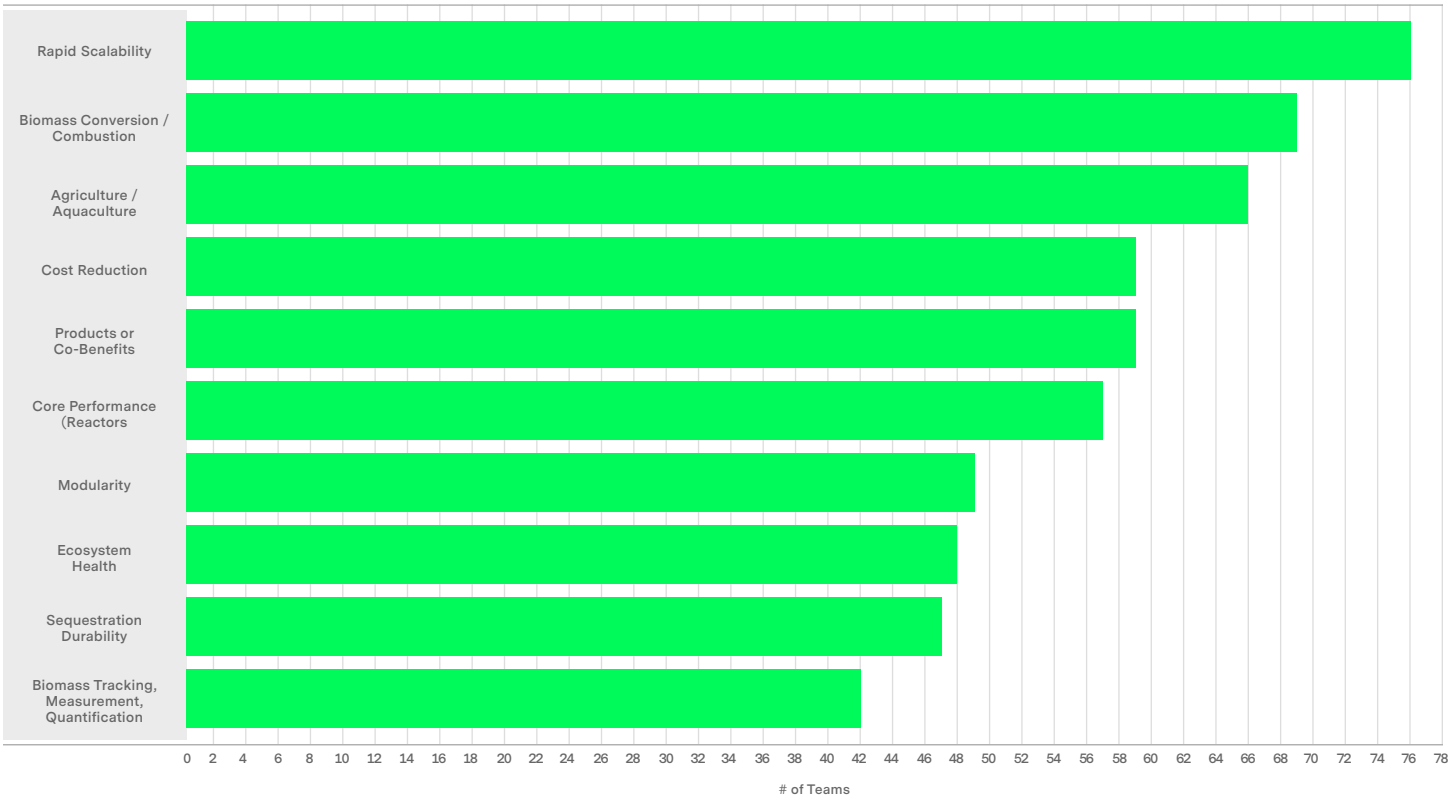
INNOVATION PRIORITIES

The most frequently cited priority areas for innovation for Teams working on Land CDR include:

76	69	66	59	59
Rapid Scalability	**Biomass Conversion or Combustion**	**Agricultural / Aquaculture Practices**	**Cost Reduction**	**Production of Products or Co-Benefits**

Given the maturity of land-based CDR technologies, the focus on scalability and cost reduction makes sense. The intersectionality of land-based CDR with existing industries and markets is reflected in the focus on Agriculture & Aquaculture, and the production of Products & Co-benefits.

LAND TEAMS BY INNOVATION FOCUS



HYBRID APPROACHES & COLLABORATION ACROSS TRACKS

Of the 128 Teams who indicated “Land CDR” as their primary track, 48% indicated a secondary track of Air (27), Oceans (17), or Rocks (18):

27	17	18
Collaborations with “Air” Approaches	**Collaborations with “Oceans” Approaches**	**Collaborations with “Rocks” Approaches**

Of the land-based CDR Teams who indicated a hybrid approach with other tracks, the most common hybrid approaches were as follows:

Land - Agricultural & grassland CDR (crops, soils, etc.) **Oceans -** Macroalgae cultivation (seaweed, kelp cultivation, etc.)	9
Land - Terrestrial ecosystem restoration and management (forests, peatlands, etc.) **Oceans -** Macroalgae cultivation (seaweed, kelp cultivation, etc.)	9
Land - Thermal conversion of biomass (producing biochar, hydrocarbons for storage, etc.) **Oceans -** Macroalgae cultivation (seaweed, kelp cultivation, etc.)	6
Land - Terrestrial ecosystem restoration and management (forests, peatlands, etc.) **Oceans -** Ocean ecosystem restoration and management (seagrass, corals, mangroves etc.)	6
Land - Agricultural & grassland CDR (crops, soils, etc.) **Rocks -** Mineralization of mine or industrial waste	5

OCEANS SUMMARY

OCEANS SUMMARY

There are a variety of mechanisms to capture and sequester CO_2 in the ocean: Some ocean CDR pathways leverage biological systems to capture and sequester CO_2, while others leverage technologies to extract CO_2 from the seawater.

Teams developing Ocean based CDR demonstrations for the XPRIZE represent the following pathways:

Artificial upwelling/downwelling - Managing the transfer of CO_2-rich water down into the deep ocean, or the transfer of nutrient-rich water from the deep ocean to the surface.

Biomass sinking - Managing the transfer of biomass from the surface ocean into the deep ocean, where the carbon will be sequestered.

Electrochemical CO_2 separation - A number of electrochemical methods can be used to separate CO_2 from ocean water.

Macroalgae cultivation - This includes growing and harvesting kelp and other 'seaweed'

Microalgae cultivation - This includes managing the growth of phytoplankton

Nutrient fertilization - Adding nutrients to nutrient-limited areas to facilitate the growth of phytoplankton or other biomass.

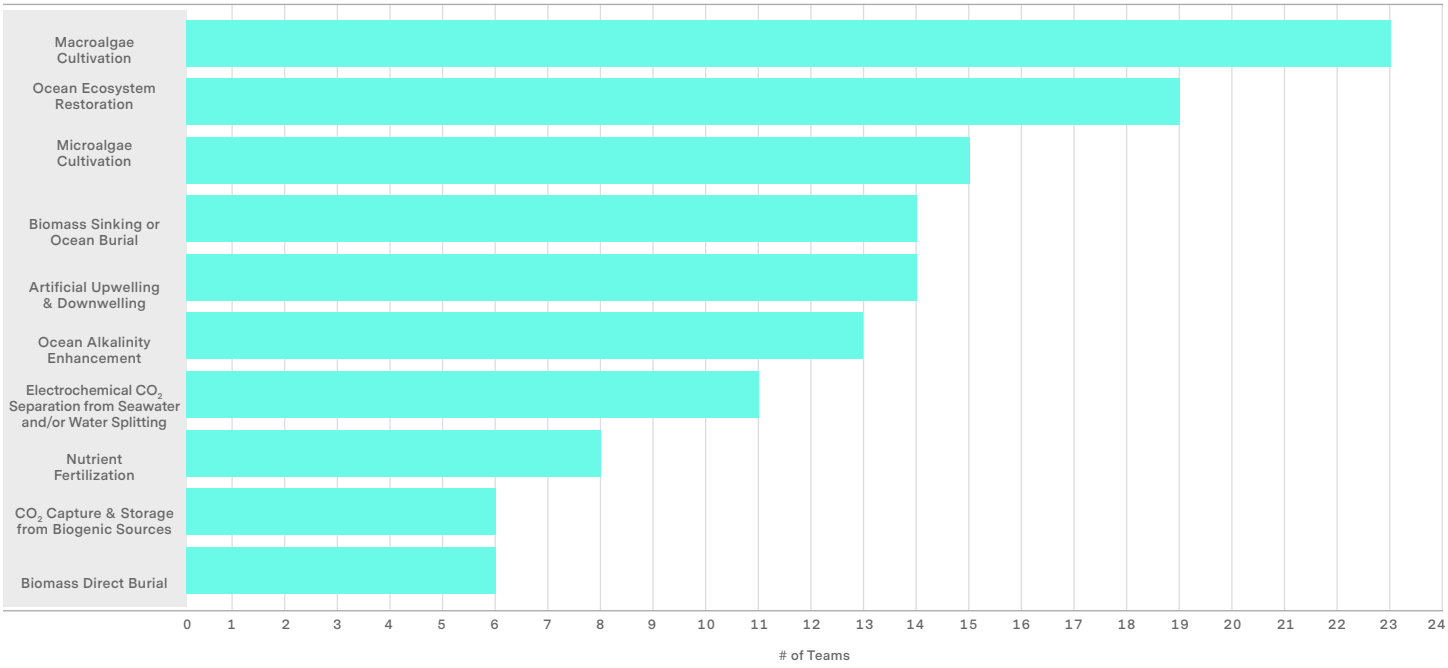
Ocean alkalinity enhancement - Mining or synthesizing alkaline materials, and adding them to the ocean to react with dissolved CO_2 in the seawater.

Ocean ecosystem restoration - Restoring marine ecosystems sequesters CO_2 in standing biomass and other aquatic life.

OCEANS SUMMARY

56 Teams selected Oceans as their primary track, and an additional 41 indicated Oceans as their secondary track. Those 97 Teams further indicated that they are working across the following pathways (multiple selections were allowed):

OCEANS TEAMS BY PATHWAY



Of the Teams who selected more than one Oceans pathway, the following represent the most common combinations of hybrid approaches:

16

- Macroalgae Cultivation
- Biomass Sinking or Ocean Burial

15

- Macroalgae Cultivation
- Ocean Ecosystem Restoration and Management

15

- Macroalgae Cultivation
- Mircroalgae Cultivation

10

- Biomass Sinking or Ocean Burial
- Artificial Upwelling and Downwelling

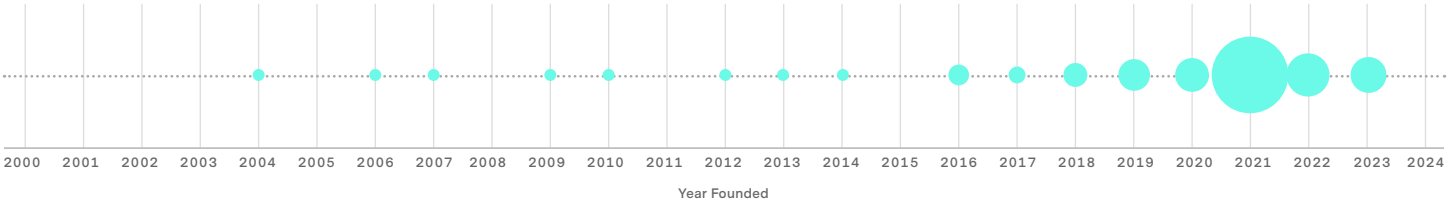
10

- Microalgae Cultivation (phytoplankton, etc.)
- Nutrient Fertilization

GROWTH OF OCEAN-BASED CDR

Ocean-based CDR is relatively young as a field, with 66% of Teams being founded since the launch of XPRIZE Carbon Removal in 2021.

OCEANS TEAMS BY FOUNDING YEARS



TECHNICAL MATURITY OF OCEAN-BASED CDR

Of all Teams pursuing an Oceans pathway, very few efforts have progressed beyond a Technology Readiness Level (TRL) of 7, with a plurality of Teams (30%) reporting a TRL of 6 or 7. “Engineered” solutions such as Electrochemical CO_2 separation report a lower TRL than “Biogenic” solutions such as Biomass sinking or ocean burial.

OCEANS TEAMS BY TRLS

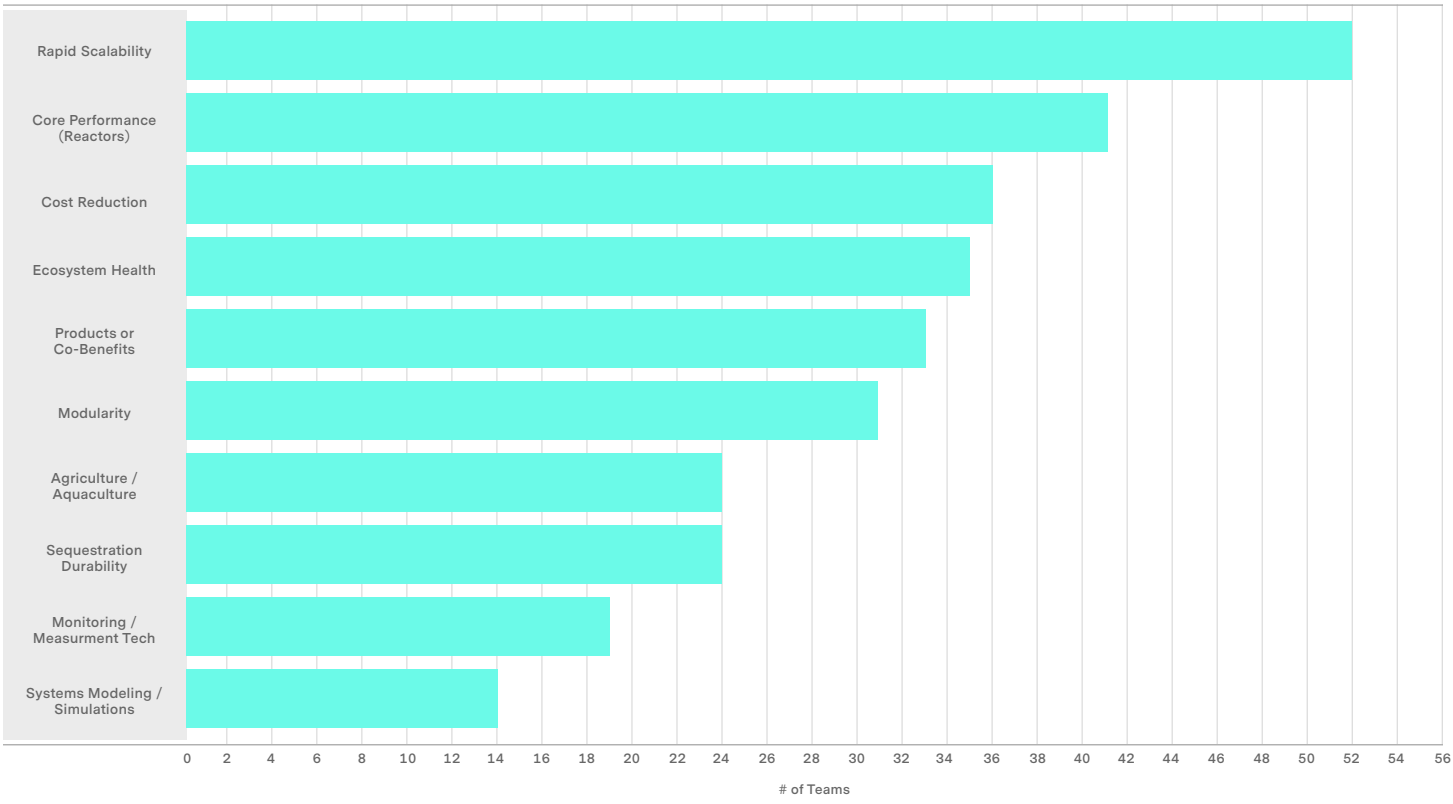
INNOVATION PRIORITIES

The most frequently cited priority areas for innovation for Teams working on ocean-based CDR include:

52	41	36	35	33
Rapid Scalability	Core Technology Performance	Cost Reduction	Ecosystem Health	Production of Products or Co-Benefits

Given the relatively low maturity of ocean-based CDR technologies, the focus on technology performance makes sense. Furthermore, given the delicate ecosystems hosted by the oceans, a focus on ecosystem health and co-benefits by innovators is encouraging.

OCEANS TEAMS BY INNOVATION FOCUS



HYBRID APPROACHES & COLLABORATION ACROSS TRACKS

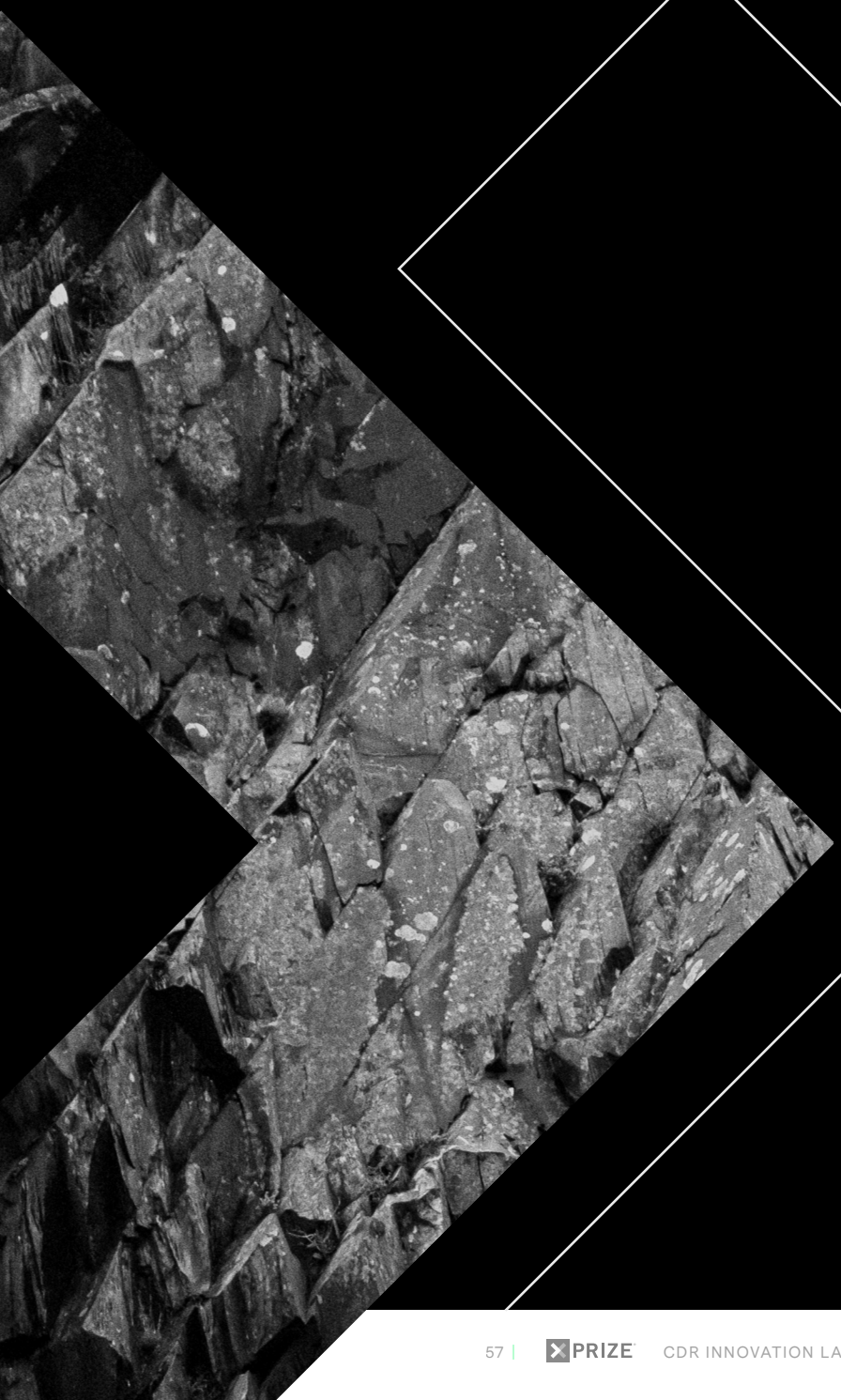
Of the 56 Teams who indicated Oceans as their primary track, 61% indicated a secondary track of Air (13), Land (8), or Rocks (13):

13	8	13
Collaborations with "Air" Approaches	**Collaborations with "Rocks" Approaches**	**Collaborations with "Land" Approaches**

Of the ocean-based CDR Teams who indicated a hybrid approach with other tracks, the most common hybrid approaches were as follows:

Oceans - Macroalgae cultivation **Land -** Thermal conversion of biomass (producing biochar, hydrocarbons for storage, etc.)	9
Oceans - Macroalgae cultivation **Land -** Terrestrial ecosystem restoration and management	8
Oceans - Macroalgae cultivation **Land -** Agricultural & grassland CDR (crops, soils, etc.)	8
Oceans - Microalgae cultivation **Land -** CO_2 capture and storage from biogenic sources	7
Oceans - Electrochemical CO_2 separation from seawater and/or water splitting **Air -** Electrochemical direct air capture	7

ROCKS SUMMARY



ROCKS SUMMARY

The concept of using rocks to remove CO_2 from the atmosphere is based on the fundamentals of mineral carbonation.

This process occurs naturally over thousands of years as carbon dioxide reacts with certain types of rocks to form stable minerals, a process called weathering. By accelerating this process, we can harness the power of these reactive minerals to remove carbon dioxide on a much faster timescale. Rocks-based methods can be divided into two broad categories: those that happen underground (known as in situ mineralization) and those that happen above ground by exposing crushed rocks to CO_2 bearing gasses (known as ex-situ or surficial mineralization).

Teams developing Rocks- based CDR demonstrations for XPRIZE Carbon Removal represent the following pathways:

Calcination of minerals with CO_2 capture - This involves using high temperature to break down minerals into CO_2 and mineral oxides - which can then be used to capture more CO_2 .

Ex-Situ mineralization of mined rocks - Reactive rocks are mined, crushed, and otherwise treated to enhance the rate of CO_2 capture.

In-Situ mineralization (mafic or ultramafic mineralization, etc) - CO_2 is injected into reactive reservoirs where the CO_2 is permanently converted into carbonate minerals.

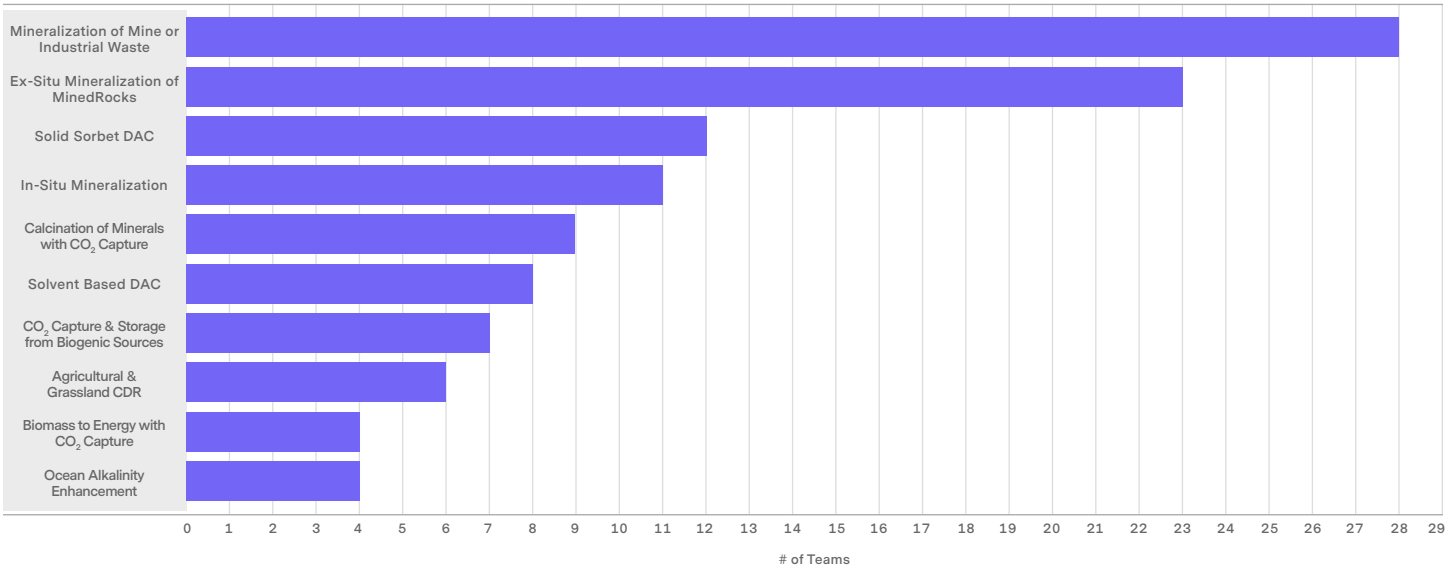
In-Situ storage in sedimentary reservoirs - CO_2 is injected into deep reservoirs where high confining pressures keep the CO_2 contained for millenia.

Mineralization of mine or industrial waste - CO_2 can be reacted with tailings from industrial processes to sequester the CO_2 and treat the tailings.

ROCKS SUMMARY

44 Teams selected Rocks as their primary track, and an additional 48 indicated Rocks as their secondary track. Those 92 Teams further indicated that they are working across the following pathways (multiple selections were allowed):

ROCKS TEAMS BY PATHWAY



Of the Teams who selected more than one Rocks pathway, the following represent the most common combinations of hybrid approaches:

17

- Mineralization of mine or industrial waste
- Ex-situ mineralization of mined rocks

12

- Calcination of minerals with CO_2 capture
- Mineralization of mine or industrial waste

9

- Calcination of minerals with CO_2 capture
- Ex-situ mineralization of mined rocks

5

- In-situ mineralization
- Mineralization of mine or industrial waste

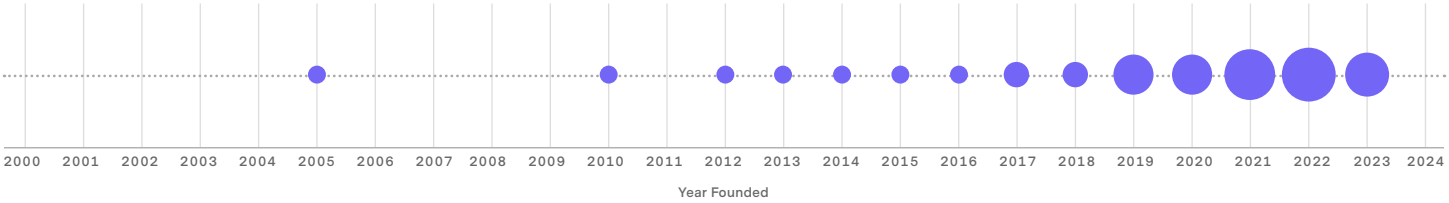
4

- In-situ mineralization
- Ex-situ mineralization of mined rocks

GROWTH OF ROCKS-BASED CDR

Rocks-based CDR has deep connections to established industries like oil and gas and mining. However, new companies and novel approaches are being developed with 52% of Rocks-based CDR Teams (23 out of 44) having been founded since 2021.

ROCKS TEAMS BY FOUNDING YEARS



TECHNICAL MATURITY OF ROCKS-BASED CDR

Overall this Track is on the more mature end compared to Air, Land, and Oceans. Many of the rocks-based Teams are in the TRL 6-7 range, with “calcination of minerals with CO2 capture” being the most advanced followed by “mineralization of mine or industrial waste”. Fewer rocks-based Teams are at TRL 1-2 than all of the other tracks.

ROCKS TEAMS BY TRLS

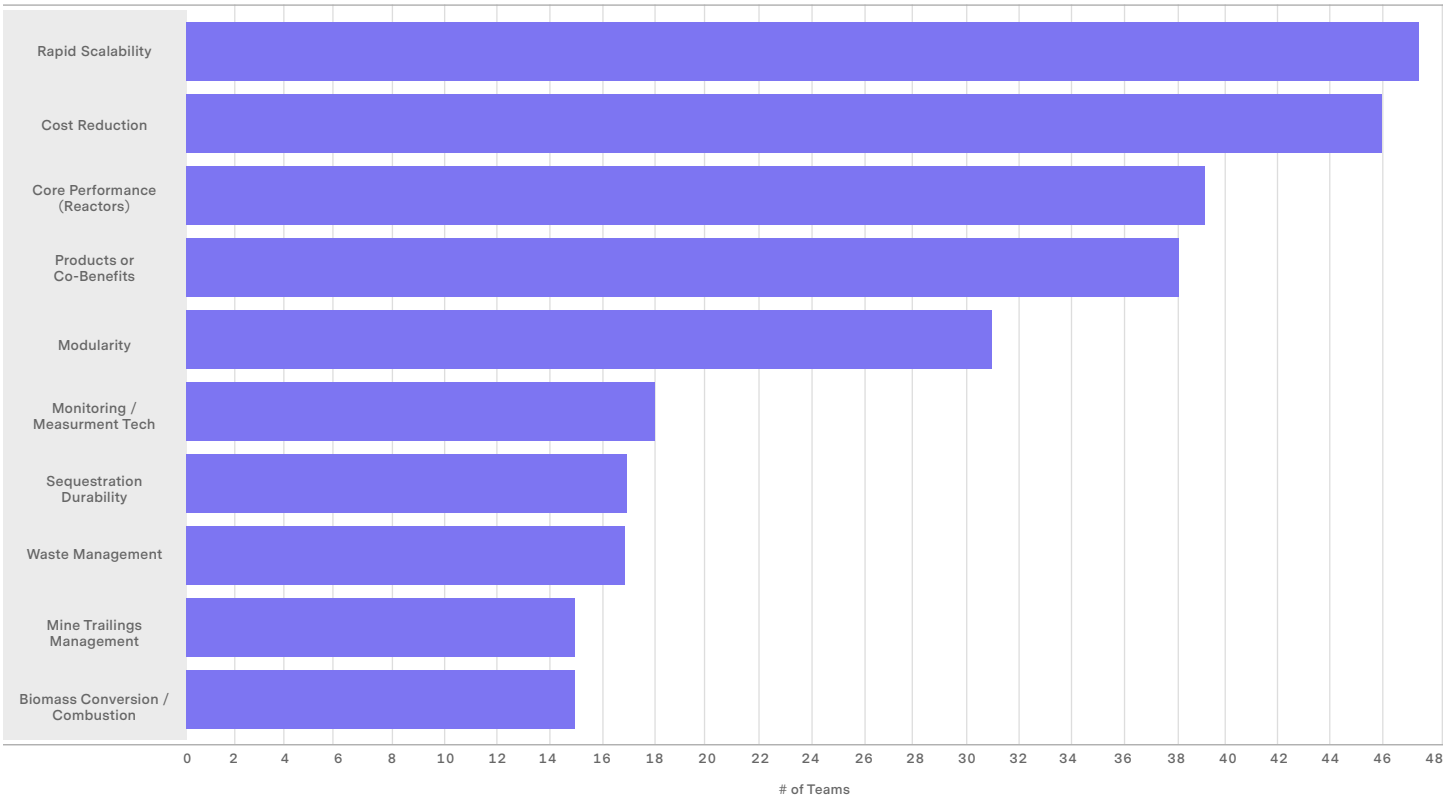
INNOVATION PRIORITIES

The most frequently cited priority areas for innovation for Teams working on rock-based CDR include:

47	46	39	38	31
Rapid Scalability	Cost Technology	Core Technology Performance (Reactors, etc.)	Production of Products or Co-Benefits	Modularity

Similar to the overall cohort, most Rocks-based Teams are focusing on scalability, cost reduction, performance, and products. Additional areas of importance for this track include waste management, sequestration durability, and mine tailings management.

ROCKS TEAMS BY INNOVATION FOCUS



HYBRID APPROACHES & COLLABORATION ACROSS TRACKS

Of the 44 Teams who indicated Rocks as their primary track, 73% indicated a secondary track of Air (21), Land (8), or Oceans (3):

21	8	3
Collaborations with "Air" Approaches	**Collaborations with "Land" Approaches**	**Collaborations with "Oceans" Approaches**

Of the rocks-based CDR Teams who indicated a hybrid approach with other tracks, the most common hybrid approaches were as follows:

Rocks - Mineralization of mine or industrial waste **Air -** Solid sorbent direct air capture	16
Rocks - Ex-situ mineralization of mined rocks **Air -** Solvent based direct air capture	9
Rocks - Mineralization of mine or industrial waste **Air -** Solid sorbent direct air capture	9
Rocks - Calcination of minerals with CO_2 capture **Land -** CO_2 capture and storage from biogenic sources	6
Rocks - Mineralization of mine or industrial waste **Oceans -** Ocean alkalinity enhancement	6

APPENDIX A – LIST OF TEAMS

XPRIZE CARBON REMOVAL

APPENDIX A – LIST OF TEAMS

Below is the list of the 333 Teams that completed the Intent to Compete Submission on September 7, 2023. For more information on the Teams, see the XPRIZE Carbon Removal website: www.xprize.org/carbonremoval

1point8*	Best Technologies Inc*
287K*	BeyonDAC**
3JC Technologies & Services Project C A	BiCOS
A Thermostat for the Planet	Bio-Agtive Emissions CCUS Technology*
AC Carbon Capture*	Bio-Capture**
AI Algae	BioCarbon
AI TREE	Biochar Now
Air Company**	biocharade*
Airhive	Bioeconomy Institute Carbon Removal Team***
Alaska Future Ecology Institute	BioFix
ALIGNMENT ENERGY	Biomass Sequestration for Direct Capture of CO2*
All Power Labs*	Biomethane & CCS
AnbayTerra	BioSol*
Andes	BIOSORRA*
Angel Sharks	Bird Eight
Answer of Biochar (AOB)*	Bison Underground*
Anthropogea	Blue Carbon
AO Farm	Blue Lotus Solutions*
Aonbarr	Blue Skies Minerals
Apotheosis2	Blue Symbiosis
Arca Climate Technologies (Previously Carbin Minerals)***	Blue Water Bioproducts
ARCTECH USA*	Bluegreen Water Technologies
Arktide	BluSky*
ARTi**	Borna Energy
Asperd	Box of Scraps
Aspiring Materials**	Brineworks BV
AT-ONCE	Butterfly Team*
Atrium*	C Sink
Badgersett Research New Food Crops*	C-Crete Technologies
Bakz4ever	C2 (C-Squared)**
BamCore**	C4X
BE CDR! (Previously Landwaerme & bioCORE)**	CaCO3carbon

APPENDIX A – LIST OF TEAMS

CAGE (Composites Adsorbing Greenhouse Emissions)	Charm Industrial**
Calcite Carbon Removal***	Circularity2
Canadian Carbon	Clean Air Tech Limited
Captura***	ClimaFauna
Capture6	Climate Robotics*
Capturing Carbon to End Hunger*	ClimateAdd**
Carb Seq	CO2 Harvester for Households
Carba	Cool Ventures
Carbek	Cowboy Clean Fuels
Carbo Culture*	COzTERRA
Carbofex**	Cquestr8 Ltd*
Carbon Atlantis	Craste
Carbon Blade*	CREW Carbon
Carbon EX	CROPS*
Carbon Gardens*	Crown Monkey
Carbon Limit*	Daedalus Collective
carbon loser with costs of -13 dollars per ton	DCarbon
Carbon Mines	DeCarbon Tech
Carbon Negative CO2	Desert Ocean
Carbon Negative Rice System*	Dgreen Tech
Carbon Neutral Initiative*	Direct Air Capture**
Carbon Quest*	DuoSophist
Carbon4Climate Canucks	E-quester**
Carbonaught Pty Ltd**	Eagle's Thunder
CarbonCapture Inc	Earth Merchant
CarbonCure**	Earth RepAIR**
Carboniferous*	Earth Vaccine*
CarbonRun	earth4Earth
Carbonspheric Solar Biochar	Ebb Carbon**
CarbonSync by Mormair	ECAS
Carbyon**	Ecolime
CCIP GREEN INITIATIVES PROJECT	ecological & energy engineering
Cestore	Ecomerit Technologies of the Pacific*
Char2Cool*	EcoRestoration Alliance*

APPENDIX A – LIST OF TEAMS

EDAC Labs	Hempcreteyurt*
EECS	Hempoffset - Tao Climate*
EKNEFES	Holocene Climate*
ELDACS	Holy Grail Inc
Electric Carbon Miners	HY-TEK Bio
ELITELCO*	Hydroponica Homes*
EMID*	Ichthion
Emissions Capture and Recovery	INNONEP OCEAN*
EPFL Carbon Team**	INNOvative Negative Emission Project*
Everest Carbon	InterEarth*
Farmers' Helper*	Jeevan
Fine Silicate Soil Weathering	jigan enerji*
Food Team	JMCC WING, LLC*
From Day One	K- Carbon Mineralization Flagship Center*
Fuego del Sol Haiti (FdS) Social-Eco Enterprise*	Kelp Blue*
Full Mitigation Science (FMS)	Kepler Carbon ReCapture*
FUTURE SCHOOLS	KFC(KelpFarmCareer)**
GaiaRefinery	KFC**
Geo Batteries	LATI
Gigaton CO2	Levitree
Global Algae Innovations***	Limenet
Global Thermostat	Living Carbon*
Globe-Eco*	Loam Bio
Gomez-Rodriguez	MacroCarbon
Graphyte	MARINE CARBON FARM
Green Starship	Marine Permaculture SeaForestation***
Greener Concrete - Zeolite Composites	MASH Makes
Greenlyte Carbon	Mast Reforestation
GREENORE	Mati carbon
Growing Carbon Solutions	MCi plus DAC
H2CI Hydrogen Champions	Meadows
Hago Energetics*	Mercurius Rising**
Heimdal	MexIInventor
Heirloom***	Microalgae ploughing the world*

*** Milestone Round Qualified Team | ** Milestone Round Top 60 Team | *** Milestone Award Winner**

APPENDIX A – LIST OF TEAMS

Mimicry Maniacs*	Plantd*
Momentum Management	PlantVillage***
Mvmnt-X, Inc	Pollution Controls*
NDR Technologies	Powermaster
Nefes	Prakruti
Nellie	Project Abyss
nelpustudio*	Project Aero
NeoCarbon GmbH	Project ARROW
Neolithe*	Project Baqara (44.01)
NEORICE	Project Hajar (44.01)***
NetZero***	PRONOE
neustark	Pull To Refresh*
Neustark x Carbfix	Pure Carbon
NForests	Pure Shenandoah
Nidhi	PyroCCS** (previously Biochar Challenge)
NOSCE	R-D*
Noya	RaeenTek
NXT 150	Reazent*
Octavia Carbon	RepAir & Carbfix**
Omega	Repair The Sky
Omega Terraform	reverce
Open Forest Protocol	Reverse Carbon
OrcaEnergy	Reverse Carbon Mining Project**
Orenga	Rivotto, Inc
Otetto	RIZOME**
Partanna Global, Inc	RockFarm*
Passively large-scale negative emission*	Rubisco Limited
PCS New Mexico	RUBISCO2
Permacarbon*	Running Tide Technologies*
Perpetual Next**	SAPPHIRE
Photocatalytic Pavements*	SASIITB
Phykos, PBC	Schway
Planet Savers Inc	Seachange**
Planetary***	Seafields*

APPENDIX A – LIST OF TEAMS

SeaO2**
Seawater Greenhouse**
Seaweed Generation
SeeOhToo
Silicate Carbon**
Sinkco Labs
Sitos Group
Skyology*
Skyrenu Technologies**
Solar Algae
Solubag
SolveCO2
Sonnenerde**
SpiralWave
SPSC GmbH*
Stark Drones
Stealth CDR Project*
Sustaera***
T - C
Takachar***
Tau Carbon*
TBD-DE
Team Deep FREEze*
Team FREEway*
Team Home-FREE*
Team Lichen*
TecnoFiltro SCS
TeraTon-PlusPlus
TerraFixing**
teRRRa - Wetlands*
The AJEEB Project*
The Carbon Protocol Initiative*
The Hemp Team
The Phoenix Tree Project*
The team of Ltd Teodora*
Thermodynamic Geoengineering*
Thiazzi
Tierra Prieta*
Totoka Islands*
Travertine Technologies
Trimble and Riley
Tuvalu 51
Uhart Carbon Harvest
Ultra scalable DAC to mineralization
Undesert Corporation*
UNDO Carbon
UNEFY | TEAM UNEFY
Unemit
Universal Carbon Technologies Inc
Vaulted Deep
Verde's Team
veritree
Vesta
WAFFLE'S
Watt4Me*
WeNeW Carbology
Whale X - Ocean Nourishment Deep Sea Carbon eXport**
Wild Bio
Wild Hydrogen
Wood Vault**
Working Trees
X-PROJECT
Yuanchu Tech**
Zero Carbon Production**
ZS2 Technologies**

*** Milestone Round Qualified Team | ** Milestone Round Top 60 Team | *** Milestone Award Winner**

XPRIZE
CARBON
REMOVAL

MUSK FOUNDATION

CDR INNOVATION LANDSCAPE & 2024 OUTLOOK

SEPTEMBER 2023