



BIOCHAR: UNLOCKING SUSTAINABLE SOLUTIONS



ABOUT GOMASSIVE

GoMassive is building an Asia-focused global Climate Innovation Network, uniting founders, investors, corporates, government bodies, and policymakers through deep, symbiotic partnerships across high-growth climate markets.



INVESTMENT



SEBI CATEGORY-1 ANGEL AIF

Portfolio



INDRA
EVERYTHING WATER.



ACCELERATOR



CORPORATE INNOVATION PROGRAM

Partners

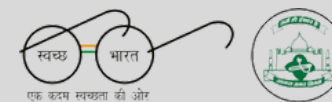
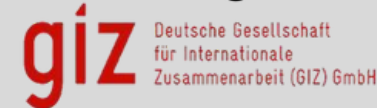


CSR & GRANT

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SECTION 8 NON-PROFIT COMPANY

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RESEARCH

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EVENTS

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ABOUT CLIMATE ANGELS

Climate Angels is a SEBI regulated Cat-1 Angel fund focused on creating a sustainable future by exclusively investing in companies working on Pollution Reduction and Climate Change. We invest in startups working on Agriculture, Clean Mobility, Water, Waste, and Built Environment (Clean & sustainable cities). We have invested in a total of 22 companies till date.

Portfolio Companies



Notable Co-Investors



GOMASSIVE: SUITE OF SERVICES

GoMassive is working towards building a global Climate Innovation Network uniting founders, investors, corporates, government bodies, and policymakers through symbiotic partnerships.

It empowers founders to build and scale their ventures with a comprehensive suite of solutions, from fundraising to post-investment management.

1. Fundraising Solutions

RUV (Roll up Vehicle)

- As a founder, you can easily create a funding round on the platform and share it with committed investors like friends, family, and angels.
- Through RUV, the entire raise is consolidated into a single cap table entry.

Climate Angels & Syndicate

- Raise through Climate Angel Investors.
- Leverage your proprietary investor network to raise capital, or choose to access the GoMassive capital network, enabling investments through deal-specific special purpose vehicles (SPVs).

GOMASSIVE IB

- Access to a global network of VCs, Corporates and Impact Investors
- Offers end-to-end support across Fundraising (Seed to Growth Stages), Corporate Finance & Structuring, Valuation, Market Strategy, and Investor Relations & Pitch Advisory.

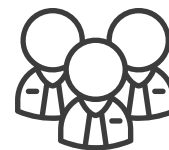
GOMASSIVE: SUITE OF SERVICES

2. POST INVESTMENT TOOLS



Captable Management tool

Real-time cap table updates with scenario analysis.



Employee Stock Option Management

Manage employee stock options with ease and accuracy



MIS Updates to Investors

Share regular updates on company performance with investors

3. ADDITIONAL SERVICES



GoMassive Community

Becoming a part of the GoMassive community, invites to climate events and community programs



Mentor Connect

Guidance and support through 1:1 mentorship sessions while you build your business



Co-Working Spaces

GoMassive partners with leading coworking spaces offer the best coworking solutions across India.



gomassive.in



contact@gomassive.org



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What is Biochar?

Biochar is a stable, carbon-rich material produced by the thermochemical conversion of biomass in a low-oxygen environment (typically through pyrolysis or gasification).

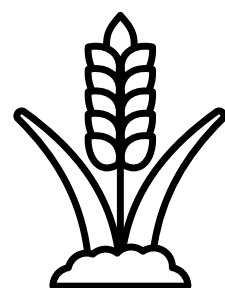
It is designed primarily for carbon sequestration, soil enhancement, and industrial applications, such as filtration and construction materials.

Because of its high fixed-carbon content and chemical stability, biochar can lock away atmospheric carbon for hundreds to thousands of years, making it one of the most scalable forms of durable carbon removal.



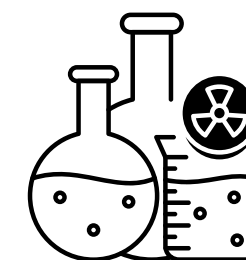


Key Properties of Biochar



PHYSICAL PROPERTIES

- Porosity: Highly porous structure → increases water retention and microbial habitat
- Surface Area (BET): Typically 50–400 m²/g; high surface area improves adsorption and nutrient retention
- Bulk Density: Low bulk density (80–200 kg/m³) → impacts logistics and application rates



CHEMICAL PROPERTIES

- Hydrogen-to-Carbon (H:C) Ratio: Key indicator of carbon permanence, an H/C ratio below 0.7 is the standard for "stable" biochar (IBI/EBC), while below 0.4 indicates "highly stable" (persistent for centuries)
- pH: Usually alkaline (pH 7–10), depending on ash content; beneficial for acidic soils
- Nutrient Content: Contains minerals like Ca, K, Mg, P depending on feedstock





Global Investor Momentum

BIOMASS FARMING MARKETS REMOVAL

Qualterra To Offer Biochar Carbon Credits Powered By \$4.5M Funding

SEEING GREEN

Houston climatetech startup raises \$21.5M series A to grow robotics solution

 Natalie Harms Aug 5, 2024, 1:47 pm



Applied Carbon Raises \$21.5 Million for Biochar Carbon Removal Technology

 Susan Lahey August 6, 2024

Environmental solutions startup Applied Carbon, whose technology converts in-field agricultural crop waste into biochar, announced today that it has raised \$21.5 million in a Series A funding round, with proceeds aimed at deploying a fleet of biochar machines across Texas, Oklahoma, Arkansas, and Louisiana.

INVESTMENT STARTUPS

NetZero Biochar Carbon Removal Startup Raises €11M In Series A

 by Petya Trendafilova · February 9, 2023 · 2 minute read

NVIRONMENT / PRIVATE EQUITY & VENTURE CAPITAL

Carbon Removal Startup Standard Biocarbon Raises \$5 Million to Launch U.S. Biochar Production Facility

Press Releases

Terraton Raises \$11.5M to Scale Biochar Carbon Removal in Emerging Markets

Integrated software, hardware and financing solution building two biochar facilities in Ghana and Kenya, turning agricultural waste into carbon revenue for thousands of farmers

August 27, 2025 8:00 PM GMT+5:30 · Updated August 27, 2025



ecoLocked Secures €4M In Seed Funding For Biochar Carbon Removal

 by Theodora Stankova · June 5, 2024 · 2 minute read

Finland's Carbo Culture Completes \$18M Series A Funding Round

 by Theodora Stankova · November 29, 2023 · 2 minute read

USDA Awards \$20.49 Million Grant To Biochar Project

OCTOBER 31, 2024

The USDA on Oct. 30 awarded \$120 million to six fertilizer production projects through its Fertilizer Production Expansion Program. One of the awards will support the development of a biochar project in Port Angeles, Washington.

The agency awarded a \$20.49 million grant to Myno 001 LLC, a wholly owned subsidiary of Myno Carbon Corp. The grant funding will help offset the costs of constructing a large-scale biochar carbon removal facility. According to the USDA, facility will convert waste timber biomass into biochar to be used as an agricultural soil amendment.





Funding in Indian Startups

Kering-backed fund Mirova pours \$30.5M into India's Varaha for regenerative farming

Jagmeet Singh — 9:00 PM PDT · November 10, 2025

MASH Makes secures EUR 2 million from Nefco

MASH Makes has received a new, additional loan of EUR 2 million from Nefco – the Nordic Green Bank. The loan will be used to construct our second commercial pyrolysis facility near Udupi, Karnataka, India, adjacent to the site of our first project financed by Nefco in 2022. This second loan increases the total Nefco financing received to EUR 3.75 million.

Climate-tech startup Equilibrium raises \$3 million in seed funding from Peak XV, Kalaari, Avaana

The capital will be used to expand eight projects across nine states, covering 120,000 hectares of land and involving over 150,000 smallholder farmers

Alt Carbon scores \$12M seed to scale carbon removal in India

Jagmeet Singh — 8:00 PM PDT · May 21, 2025





BENEFITS & USES

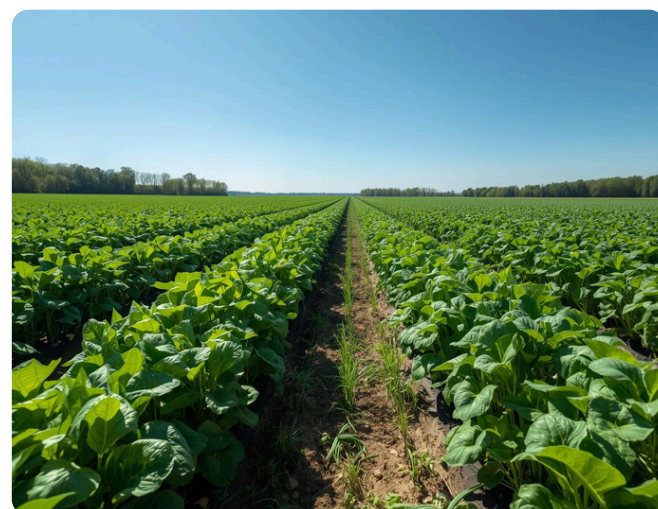
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- 19** Use of Biochar in Textiles





Agricultural Benefits

Yield Enhancement



Biochar improves crop yields by enhancing soil fertility and promoting plant growth effectively.

Nutrient Retention



By retaining nutrients, biochar helps prevent leaching and enhances soil quality for crops.

Reduced Fertilizer Use



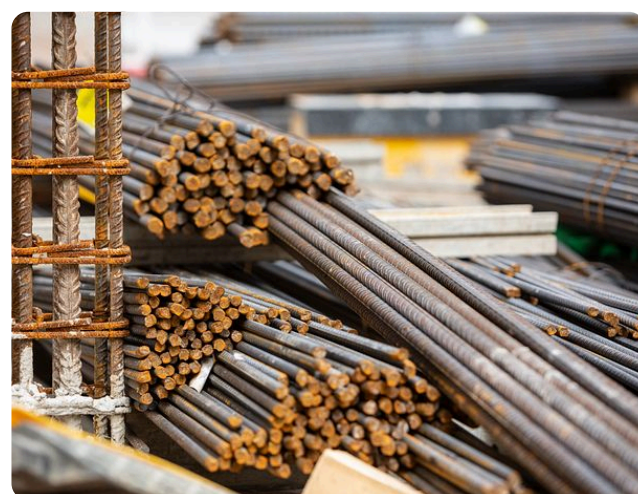
Incorporating biochar can significantly reduce fertilizer dependency, promoting sustainable agriculture practices.





Industrial Benefits

Use in Construction Materials



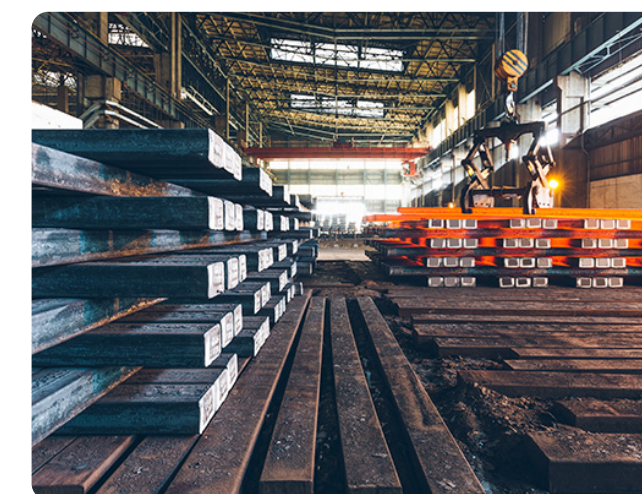
Used as an additive in cement, concrete, and asphalt to reduce embodied CO₂ and improve insulation and durability.

Filtration & Activated Carbon Substitute



Acts as a low-cost, high-surface-area adsorbent for wastewater and air purification, replacing fossil-based activated carbon.

Steel & Metallurgical Industry



Used as a renewable replacement for metallurgical coke, cutting direct CO₂ emissions in blast furnace steelmaking.

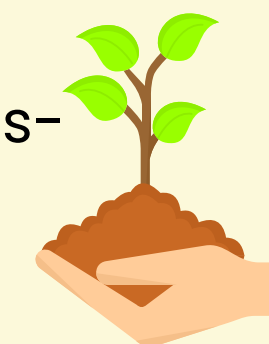




Biochar as an Agent for Soil Amendment

- Converts waste into value and produces syngas/heat that displaces fossil fuels.
- Lowers nitrous oxide (N_2O) and methane emissions, especially in paddy and acidic soils.
- Locks carbon into long-lived products like concrete, bricks, asphalt, composites, enabling carbon-negative construction.
- Prevents CO_2 , CH_4 , N_2O , and black carbon emissions from open-field crop residue burning.
- Improves fertilizer-use efficiency, reducing downstream emissions from fertilizer production and lowering indirect N_2O emissions caused by nutrient leaching and over-application.

Converts biomass into stable carbon that stays locked in soil/materials for hundreds- if not thousands- of years.





Biochar as an Agent for Climate Change Mitigation

- Instead of releasing CO₂ and methane through burning or decay, biomass is converted into stable carbon.
- Biochar application lowers methane and nitrous oxide emissions— two highly potent GHGs.
- Pyrolysis transforms biomass into fused carbon structures that persist long-term in soils.
- Biochar acts as a durable carbon sink, delivering certified carbon dioxide removal (CDR) credits.

Improves nutrient retention and can increase CEC (Cation Exchange Capacity) by 20–50%, depending on soil and biochar characteristics.





Biochar as a Construction Material

- It can replace sand in clay, lime, or cement mixtures (up to 50% blending), creating lightweight, breathable, carbon-negative plasters.
- Biochar plasters naturally regulate indoor humidity to 45–70%, preventing dry air, condensation, dampness, and mould formation.
- Biochar-enhanced plasters help remove toxins, VOCs, and odors, improving indoor environments in homes, offices, schools, and industrial spaces.
- Its high adsorption capacity helps reduce electromagnetic interference, benefiting sensitive indoor environments.
- When sprayed on external walls (up to 20 cm), biochar-lime plaster can replace Styrofoam insulation while turning buildings into long-term carbon sinks.

Biochar has very low thermal conductivity and can absorb up to 6× its weight in water, making it ideal for building insulation and humidity regulation.





Biochar in Animal Farming

- Biochar is widely used in livestock system –~90% of biochar in Europe goes into animal farming, mainly for feed, bedding, and slurry treatment.
- Biochar enhances gut function by stabilizing microbial activity and improving overall digestive efficiency.
- When used in feed, litter, or manure pits, farmers observe improvements within days—especially less odor, cleaner bedding, and better barn hygiene.
- In poultry, biochar increases nutrient absorption and energy uptake, improving feed conversion ratios.

Studies in the US Great Plains show ~9.5% reduction in methane emissions from beef cows when biochar is added to feed – important for climate mitigation.

In Detail in Annexure





Use of Biochar as a Decontaminant

- Biochar binds heavy metals, pesticides, hydrocarbons, and toxins in polluted soils—widely used in mine sites, military areas, landfills, and degraded industrial land.
- Biochar berms (30–50 cm depth) around fields, ponds, or drainage lines effectively capture pesticides, fertilizers, and chemicals before they enter surface waters.

Use of Biochar in Wastewater Treatment

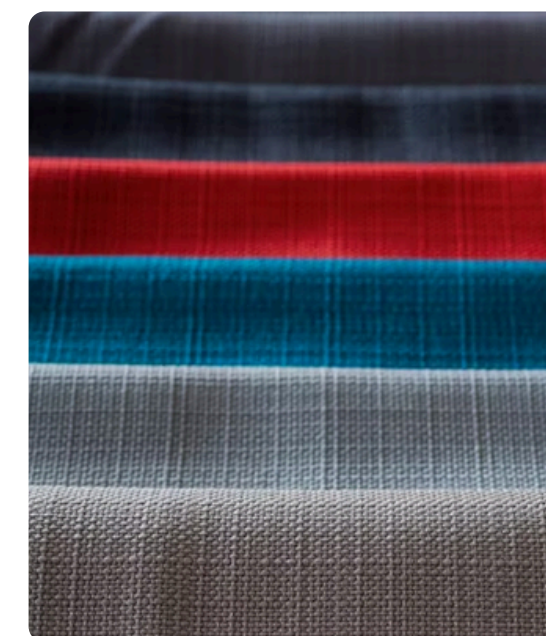
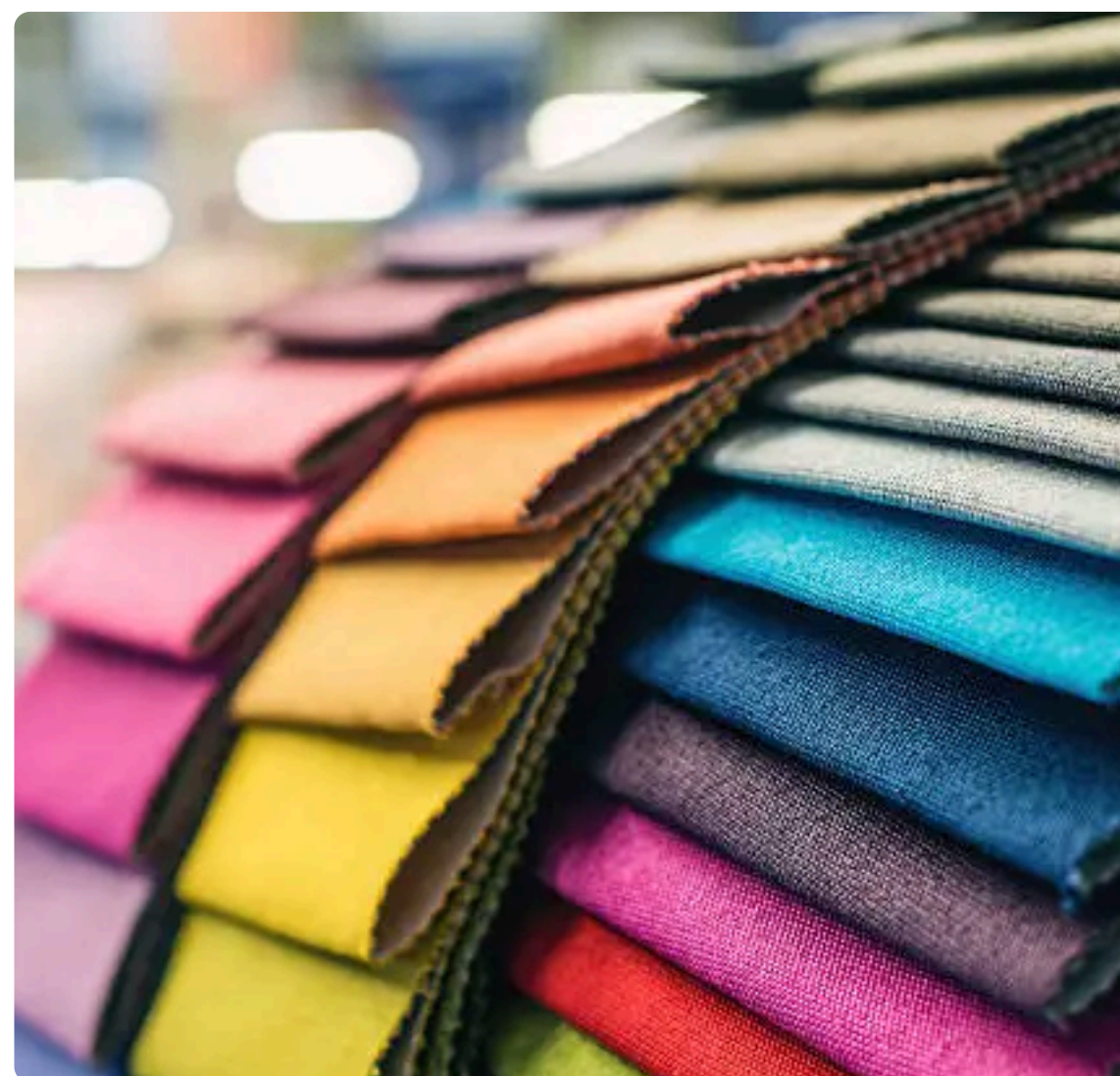
- Biochar removes heavy metals, organic pollutants (dyes, pharmaceuticals), nutrients (N, P), and suspended solids, outperforming many conventional adsorbents.
- Biochar-based biofiltration can reduce COD by up to 90% within 5 days, making it suitable for municipal wastewater polishing and industrial discharge treatment.





Use of Biochar in Textiles

- Bamboo-based biochar woven into fabrics helps absorb sweat, toxins, and odors, making it ideal for sportswear, socks, and innerwear.
- Biochar fibers naturally regulate temperature and moisture, providing better breathability and comfort in hot or humid conditions.





MARKET OPPORTUNITY



Market Size & Opportunity Analysis in India



Total Feedstock Available

- Agri residues: ~600 million tonnes/year
- MSW biomass fraction: ~ 60 million tonnes/year
- Total : 660 million tonnes/year

Assuming 30–50% is surplus & usable → 198–330 million tonnes/year.

Biochar Production Potential

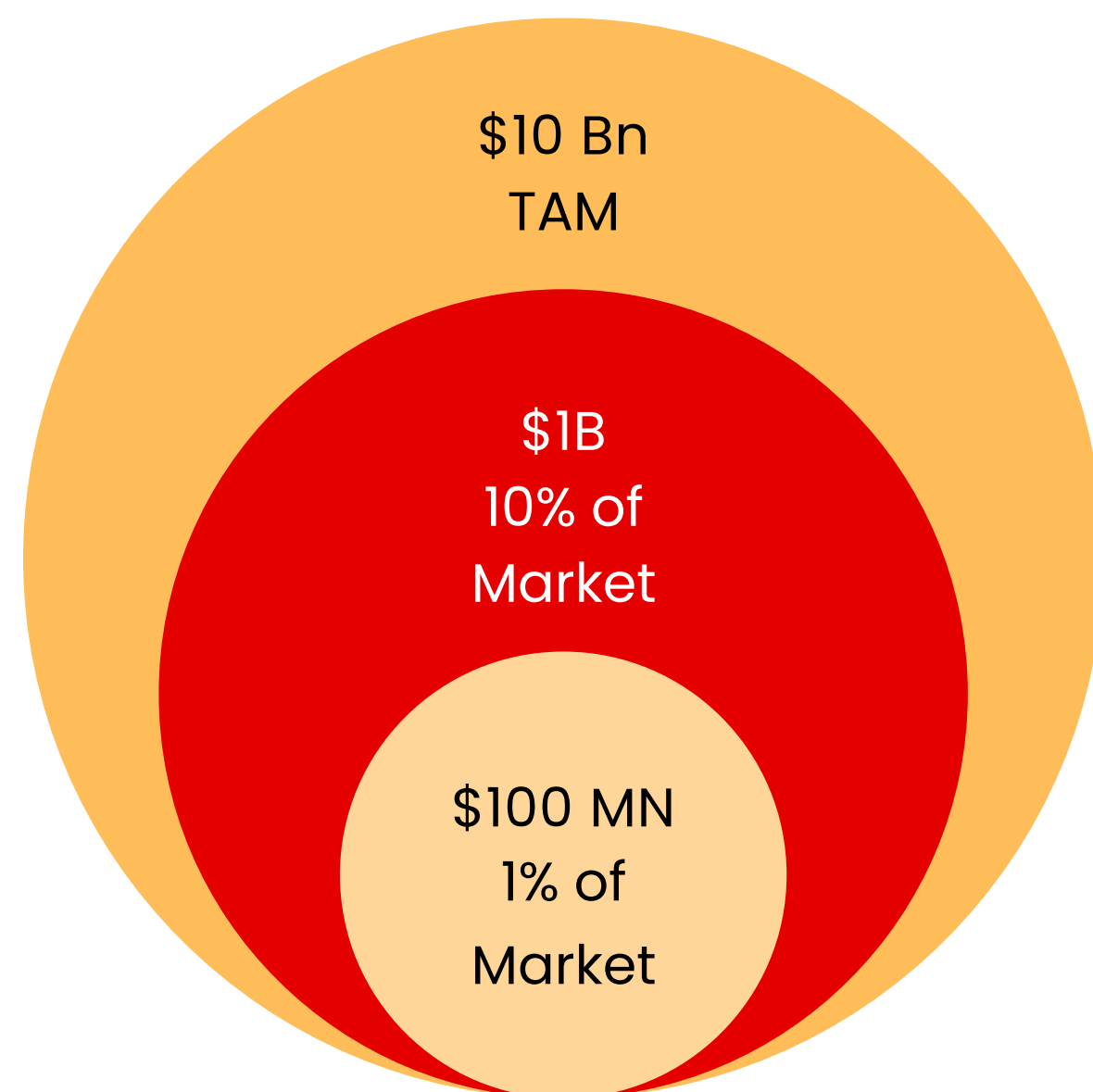
- Biochar yield $\approx$ 25–30% of biomass.

From 198–330 MMT feedstock → **Biochar = 15–26 MMT/year**





Market Size & Opportunity Analysis in India



Carbon Credit Revenue Potential

Industry standard:

- 1 tonne biochar → ~2 tCO₂e credits
- Carbon credits in a year = 30–52 million carbon credits/year

At an average price of \$100, gives a \$3B Market Opportunity

Biochar Product Market Potential

- Biochar average price in India: \$120–180 per tonne
- Revenue from 15–26 MMT production: Biochar Material Market TAM = \$1.8B – \$4.7B

Energy Co-products Market (Syngas + Bio-oil)

- 20–30 MMT syngas → 8–13 TWh electricity
- 24–40 MMT bio-oil → replaces 12–19 MMT diesel/kerosene





Global Opportunity

Biochar represents a \$80–100 Bn long-term global opportunity spanning carbon removal, materials, and energy.

Supply Potential (Long-Term)

- Global sustainable biomass availability: ~4–5 billion tonnes/year
- Usable surplus (25–35%) → ~1.0–1.5 billion tonnes/year
- Biochar yield (25–30%) → ~250–400 MMT biochar/year

Carbon Removal (CDR) Opportunity

- 1 tonne biochar → ~2–3 tCO₂e removed
- Durable CDR prices: \$100–150 / tCO₂e

Carbon Removal Market Opportunity: ~\$60–70 Bn (long-term potential)

Biochar Product Market

- Global biochar pricing (blended): \$120–250 / tonne
- Assuming 20–25% of output sold as products (agriculture, construction, filtration, materials)
- Biochar Products TAM: ~\$8–20 Bn

Energy & Co-Products

- Syngas, heat, and bio-oil displacing fossil fuels
- Monetisation via power, heat, and industrial fuel use

Energy Co-Products Opportunity: ~\$5–10 Bn





APPLICATION CHALLENGES IN INDIA

- 25** Feedstock & Logistics Challenges
- 26** Process Quality & Scale
- 27** MRV & Carbon Integrity Challenges
- 28** Economics & Market
- 29** Regulatory Policy
- 30** Research & Evidence Gaps
- 31** Limitations, Risks & Misconceptions





Feedstock & Logistics Challenges

Seasonal, Dispersed & Unreliable Biomass



Agri residues are available only during harvest cycles (2–3 months), Collection is highly fragmented and varies by geography

High Transport Costs & Low Bulk Density



Biomass transport >50 km becomes uneconomical, Low density → high trucking cost per tonne → kills margins.

Contamination & Moisture Issues



Moisture >20% reduces pyrolysis efficiency, Impurities degrade product quality and damage reactors.





Process Quality & Scale

Non-Standardized Pyrolysis Units



Small, low-tech kilns dominate India, leading to inconsistent process control and high variability in biochar quality

Equipment Reliability & OPEX



Frequent breakdowns, no certified manufacturers, limited maintenance ecosystem.

Difficulty Scaling Beyond Micro-Units



Large pyrolysis plants require continuous feed + stable supply + high CapEx.





MRV & Carbon Integrity Challenges

High Cost of Verification (MRV)



Lab testing for H:C ratio, stability, carbon content is expensive & hard to scale.

Lack of Standardized Protocols



No unified Indian standard for biochar quality, permanence, or application rate.

Risk of Over-Crediting



Biochar credits can be overstated due to incomplete life-cycle accounting and optimistic permanence assumptions.





Economics & Market

Carbon Credit Dependence



In India, biochar economics is difficult to work without carbon credits

High CapEx & Working Capital Needs



Reactors + dryers + grinders are expensive.

Weak Domestic Demand for Biochar



Farmers ARE unwilling to pay > ₹5–7/kg. Industrial uses (construction, filtration) still early-stage.





Regulatory Policy

No National Biochar Policy



No classification under FCO (Fertilizer Control Order).
No subsidy framework, no quality guidelines, no usage standards.

No Feedstock Procurement Policy



Unlike Denmark/EU, India has zero structured biomass contracting mechanisms.

No Recognition as a Carbon Removal Pathway



Clear guidelines for verification, registry, permanence, or domestic offset trading





Research & Evidence Gaps

Limited Long-Term Agronomic Studies



Very few multi-season, crop-specific, soil-type studies in India.

Lack of Life Cycle Assessment Data



No comprehensive studies on: GHG reduction potential Soil methane/ N_2O , suppression and Yield uplift across crops.

Absence of Industrial-Grade R&D



Most research is academic; no translation to commercializable products.





Limitations, Risks & Misconceptions

1. Net Emissions May Be Higher Than Stored

Pyrolysis produces CO₂ and other greenhouse gases (GHGs) — if the process is inefficient or energy-intensive, these emissions may equal or exceed the carbon stored in the biochar.

In soil, biochar can stimulate microbes that decompose native soil organic carbon faster (“priming effect”), leading to net CO₂ release rather than storage.

2. Biochar’s Structural Soil Benefits Are Often Overstated

While biochar’s porosity can improve soil aeration and bulk density, these structural benefits require high application rates (20–30 tonnes per hectare) that are economically unrealistic for smallholder farmers.

Realistic rates (2–5 t/ha) represent less than 0.1% of the soil’s volume – delivering negligible physical improvements. In India, production costs per hectare at 4 t/ha can reach ₹200,000+ (~US\$2,500), making it financially impractical.





Limitations, Risks & Misconceptions

3. Biochar as an Inert Soil Filler, not a Soil Ally

- Biochar's high fixed carbon (60–80%) and very high C/N ratio (>300:1) make it biologically inert.
- It lacks labile organic compounds that soil microbes need (e.g., sugars, proteins).
- Unlike compost, which decomposes and feeds soil life, biochar remains stable but does not actively build soil fertility.

4. Weaknesses in Research & Lack of Robust Field Data

- Despite 12,000+ papers on “biochar and agriculture,” only:
- 0.9% measured actual crop yields or biomass under real farm conditions.
- 0.9% assessed toxicity.
- Only 5.5% tracked effects beyond one growing season.
- Many studies lacked nutrient-equivalent controls, proper trial design, and real-world monitoring

5. Overapplication Risks

- Disruption of native soil microbes and reduced biodiversity, undermining the soil food web's resilience.
- Altered soil pH and nutrient cycling, which can bind essential nutrients (Ca, Mg, K) and cause deficiencies.
- Excessive application could induce water repellency in some soils and mobilize toxic compounds like PAHs, thereby harming soil health.





SOLUTIONS & INNOVATIONS: ADDRESSING THE CHALLENGES

34 Feedstock and Logistics

37 Pre-Treatment

40 Conversion & Production

42 MRV Technologies





Feedstock and Logistics

Mobile / Modular Pyrolysis Units

These are tractor-towed or containerized units that process biomass at source (currently being deployed, for instance, by Takachar, Pyreg, Bioforcetech and Applied Carbon).

They massively mitigate the problems of high transport costs, low bulk density and scattered feedstock.



A Takachar Mobile Pyrolysis Unit



An Applied Carbon Mobile Pyrolysis Unit

PROS

- Huge logistics savings.
- Work very well in smallholder geographies.

CONS

- A lower overall throughput means a higher cost/ton than mega-plants.
- Harder to fully automate.





Feedstock and Logistics

Satellite + AI Residue Mapping (SatSure, CropIn)

One effective strategy for identifying viable biomass resources is the use of satellite imagery integrated with analytical models to systematically map crop cultivation areas, estimate residue availability, and identify crop-residue burning hotspots.

By the same methodology, it is also possible to determine the most logistically and economically suitable routes to and from the location of the biomass, either for collection or for mobile pyrolysis units themselves.

PROS

- Scales cheaply.
- Works pan-India.
- Helps target dense pockets of residue.

CONS

- Still needs on-ground operations.
- Model accuracy ultimately depends on ground-truthing.





Feedstock and Logistics

Machine Vision, Smart Sorting & Precision Balers

The threefold problems of contamination, mixed residues and lack of consistency in feedstock quality can be solved by employing AI-based sorting at hubs in tandem with mechanized collection using precision balers to keep feedstock clean & segregated.



PROS

- Higher quality inputs mean better quality biochar and carbon removal credits
- Lower equipment damage.

CONS

- Capex-heavy for early-stage projects.
- Requires skilled operators, which ultimately drives up labor costs.

A John Deere Precision Baler





Pre-Treatment

Solar Drying Yards & Low-Energy Dryers

Community-level solar structures integrating simple forced-air dryers for agricultural residue can mitigate many of the problems caused by high moisture (20–60%), thereby improving feedstock quality and driving up pyrolysis efficiency.

They reduce spoilage and post-harvest losses, allowing the prolonged preservation of crops.



Below: A Raheja Solar Dryer

PROS

- Improves feedstock stability during storage and transport, reducing losses and microbial degradation.
- Well-suited for rural and decentralised biomass systems, reducing dependence on fossil-fuel-based drying.

CONS

- Weather-dependent performance limits reliability during monsoon or high-humidity periods and requires skilled operators.
- Requires land availability and longer drying cycles, potentially constraining throughput.





Pre-Treatment

Mobile Chippers/Shredders

These tractor/skid-mounted units are already being piloted for processing stubble, bamboo and coconut waste. They can reduce transport costs, solve size uniformity issues, prevent feeding blockages and circumvent any problems that may potentially be caused by uneven heating.

PROS

- Versatile and able to handle many different kinds of crop residues.
- Can be shared across multiple farms and FPOs.

CONS

- High upfront cost.
- Require consistent maintenance.
- Relatively higher operational costs.



A Bruks Siwertell Mobile Chipper





Pre-Treatment

Microwave Drying

Involves the use of microwaves to directly heat water molecules for rapid drying of bagasse/wet straw. Microwave drying promises to be an effective method for the treatment of high-moisture, hard-to-dry feedstock where solar drying is not enough.

PROS

- Fast, more energy efficient for some streams.

CONS

- Expensive equipment
- Currently at an R&D/industrial level and not yet rural-ready.



Ferrite Microwave Technologies Microwave Drying System





Conversion & Production

Modern Retort / Continuous Pyrolysis Reactors

These are sealed, controlled reactors featuring syngas recycling and precise temperature control. They typically produce biochar of a consistent quality, with a relatively high carbon content.



A Continuous Pyrolysis Reactor Image Credit: IndiaMart

PROS

- High-purity biochar (75–90% C).
- Consistent H:C ratio of < 0.7
- Produce carbon credit-grade biochar.

CONS

- High capex.
- Need a steady supply of feedstock.
- Bankable offtake.





Conversion & Production

Autothermal & Fast Pyrolysis Systems

Systems developed by Carbo Culture, Applied Carbon, and Takachar combine high-efficiency production with low overall emissions

These reactor designs overcome conventional challenges such as high fuel consumption, poor energy recovery, and the release of harmful emissions.

PROS

- Fast, more energy efficient for some streams.

CONS

- Expensive equipment
- Currently at an R&D/industrial level and not yet rural-ready.



The Ablativ Continuous Pyrolysis Plant, Developed by BioEnergy Concept





MRV (Monitoring, Reporting & Verification) Technologies

Digital MRV Platforms (Varaha, BiocharIND, Planboo)

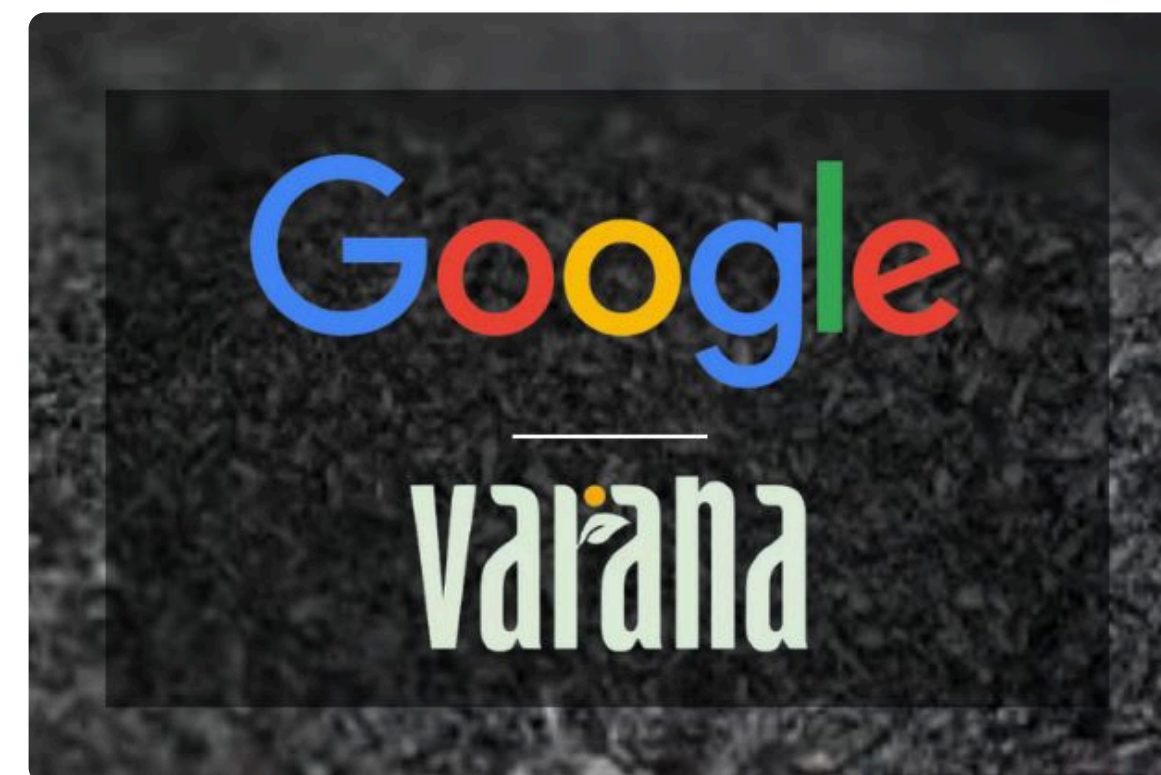
These platforms integrate mobile apps, IoT and cloud dashboards to track feedstock, reactor data, and monitor application sites. This is a relatively affordable and robust way to consolidate fragmented data and boost smallholder inclusion by cutting down MRV costs.

PROS

- Scalable across thousands of farms.
- Transparent reporting.
- High transparency and reliability allows the generation of export-grade credits.

CONS

- Despite being relatively cheaper, it is still a major cost line (\$100–200k/yr per project for full certification).



*Google recently partnered with Varaha to purchase 100,000 tonnes of carbon removal credits by 2030.
Image credit: Biochar Today*





MRV Technologies

Digital MRV Platforms (Varaha, BiocharIND, Planboo)

Digital MRV platforms reduce verification costs, enable smallholder-scale participation, and are critical for issuing high-integrity biochar carbon credits—evidenced by corporate buyers such as Google, which has procured credits from Varaha-led projects.

Google signs deal to buy carbon removal credits from Indian farms

By Reuters

January 16, 2025 4:53 PM GMT+5:30 · Updated January 16, 2025

COMPANIES / ENVIRONMENT

Microsoft Signs Largest-Ever Biochar Carbon Removal Agreement



PROS

- Scalable across thousands of farms.
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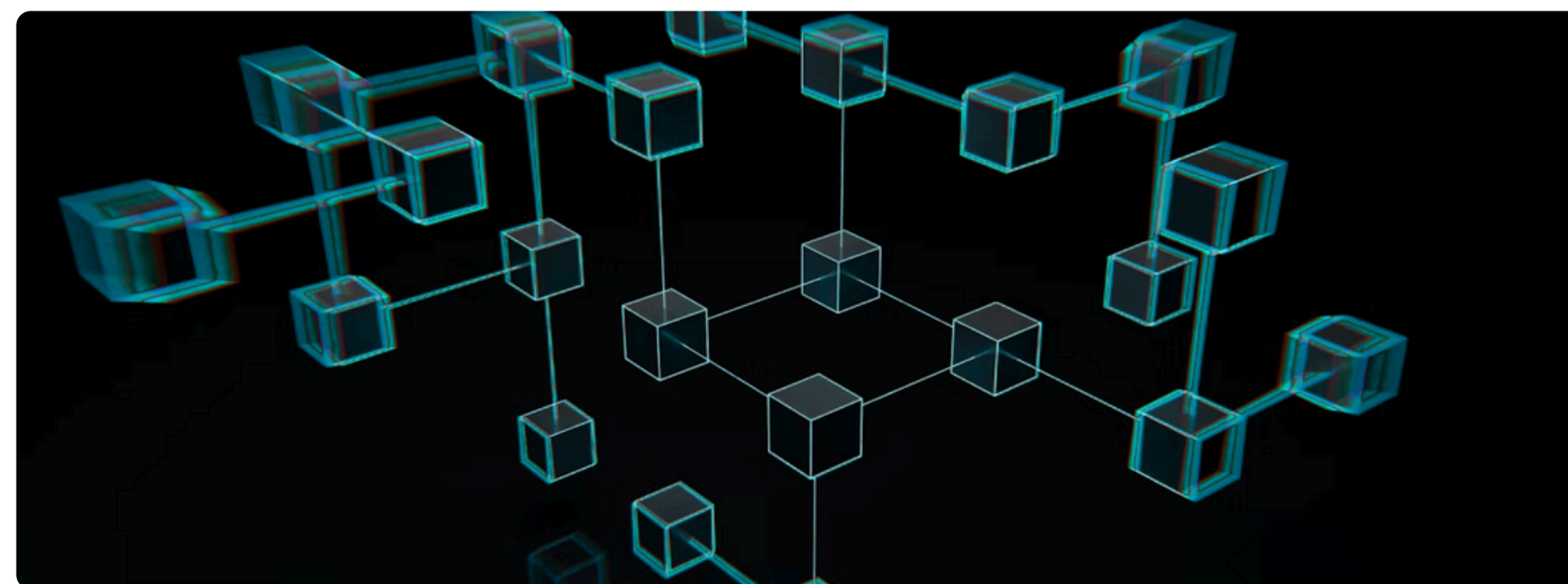


MRV Technologies

Blockchain, AI & IoT Sensors

Blockchain technology allows the generation of immutable records, while AI assists with anomaly detection and carbon prediction. IoT, meanwhile, facilitates the live tracking of temperature, gas flows and char quality.

The combined effect of deploying these technologies is to build trust, reduce the risk of over-crediting and circumvent issues commonly encountered with manual data logging, tracking and operations.



PROS

- A high overall system integrity means higher credit prices and greater investor comfort.

CONS

- Adds tech complexity.
- Depends on connectivity.
- Requires a higher level of skills to navigate.





BUSINESS MODELS

46 MODEL A -Carbon-Credit-Only Developer

49 MODEL B — Carbon Credits + Biochar Product Market (Integrated)

51 MODEL C — Decentralised Models





Business Models

MODEL A — Carbon-Credit-Only Developer

How it Works (Simple Model)

- Collect biomass → pyrolyze → produce biochar.
- Instead of selling the biochar, they bury it, apply it to soil, or dispose of it with documentation.
- The primary revenue comes from selling carbon removal credits to big corporates, climate funds, or marketplaces.

Monetization Steps:

- Project verification on Puro/EBC.
- MRV audits.
- Credits issued → sold to buyers like Microsoft, Shopify, Stripe, Frontier, Google.





Business Models

Model A — Carbon-Credit-Only Developer

Unit Economics Logic:

1. Biochar revenue is negligible; almost 100% of cash flow comes from credits.
2. These credits sell at premium rates:
 - \$100–\$180/tCO₂e on Puro.earth
 - \$150–\$300/tCO₂e for structured offtake deals
3. One tonne of biochar → ~2.5–3.0 tCO₂e → \$100–200 revenue/ton.

PROS

- Very high margins per tonne
- Simple business model, easy to explain to investors
- Can scale fast if feedstock + reactors are available
- Attractive to climate investors (pure carbon removal)

CONS

- Extremely dependent on carbon credit prices
- If methodologies tighten (as Verra paused many), revenue collapses
- Needs perfect MRV
- No real local market for biochar → less ecosystem development
- Big risk: policy uncertainty + verification delays





Business Models

MODEL A — Carbon-Credit-Only Developer (Pure CDR Play)

Companies Currently Following Model A



**carbo
culture**





Business Models

MODEL B — Carbon Credits + Biochar Product Market (Integrated)

How it Works

1. Generate biochar + credits
2. Pyrolyse residue → produce biochar.
3. Use digital MRV (IoT, satellite, field data) → certify with Puro/EBC → get carbon removal credits.
4. Sell carbon credits to global buyers, Buyers include Google, Microsoft, Shopify, Frontier, Klimate etc.
5. Sell biochar as a product
 - Agriculture: soil amendment, compost blends, horticulture media.
 - Industrial: construction filler (asphalt, concrete, screed), peat replacement, filtration media.

Economics

1. Biochar price band often \$100–150/tonne in higher-value markets.
2. So total revenue per tonne biochar ≈ \$240–500 (credits + product)





Business Models

MODEL B — Carbon Credits + Biochar Product Market (Integrated)

PROS

- Dual revenue per tonne: credits + product → more resilient economics.
- Builds real local impact: soil health, yield, industrial decarbonisation
- Farmers benefit directly → easier adoption
- Defends against carbon price drop

CONS

- Needs distribution & product standardisation
- Must develop a “quality biochar” identity
- More operational complexity
- Product-market fit varies by soil types & geographies
- Execution-heavy: agronomy, demos, trials, distribution.

COMPANIES CURRENTLY FOLLOWING MODEL B:



Standard
Biocarbon



OREGON
BIOCHAR
SOLUTIONS

MYNO
Make Carbon History



Novocarbo



CIRCULARCARBON





Business Models

MODEL C — Decentralised Models

How it Works

1. Instead of one big plant, you deploy many small / mobile pyrolysis units near farms, forests, estates, or villages:
2. This model is designed for fragmented, smallholder geographies like India, Africa, SE Asia.

Monetization Steps

1. Produce biochar locally (many small units)
 - Tractor-mounted / containerized units process crop or forest residues on-site, avoiding long-distance biomass transport.
2. Aggregate carbon credits via a platform
 - A climate/MRV platform (like Planboo or a developer partner) aggregates tonnes and issues CDR credits that are then sold to global buyers.
3. Use/sell biochar locally & regionally
 - Most biochar used in local soils, estates, plantations, or small industrial uses; sometimes sold to nearby buyers (coffee estates, cotton farmers, etc.)





Business Models

MODEL C — Decentralised Models

PROS

- Solves logistics: biomass is processed near source → huge savings in transport cost and avoids open burning.
- Tailor-made for smallholder geographies (India, Africa, SE Asia)

CONS

- Lower per-unit throughput limits economies of scale, often resulting in higher cost per tonne of biochar or CO₂ removed.
- Operational reliability depends heavily on local operators, increasing execution and training risk.

COMPANIES CURRENTLY FOLLOWING MODEL C:





INVESTMENT LANDSCAPE

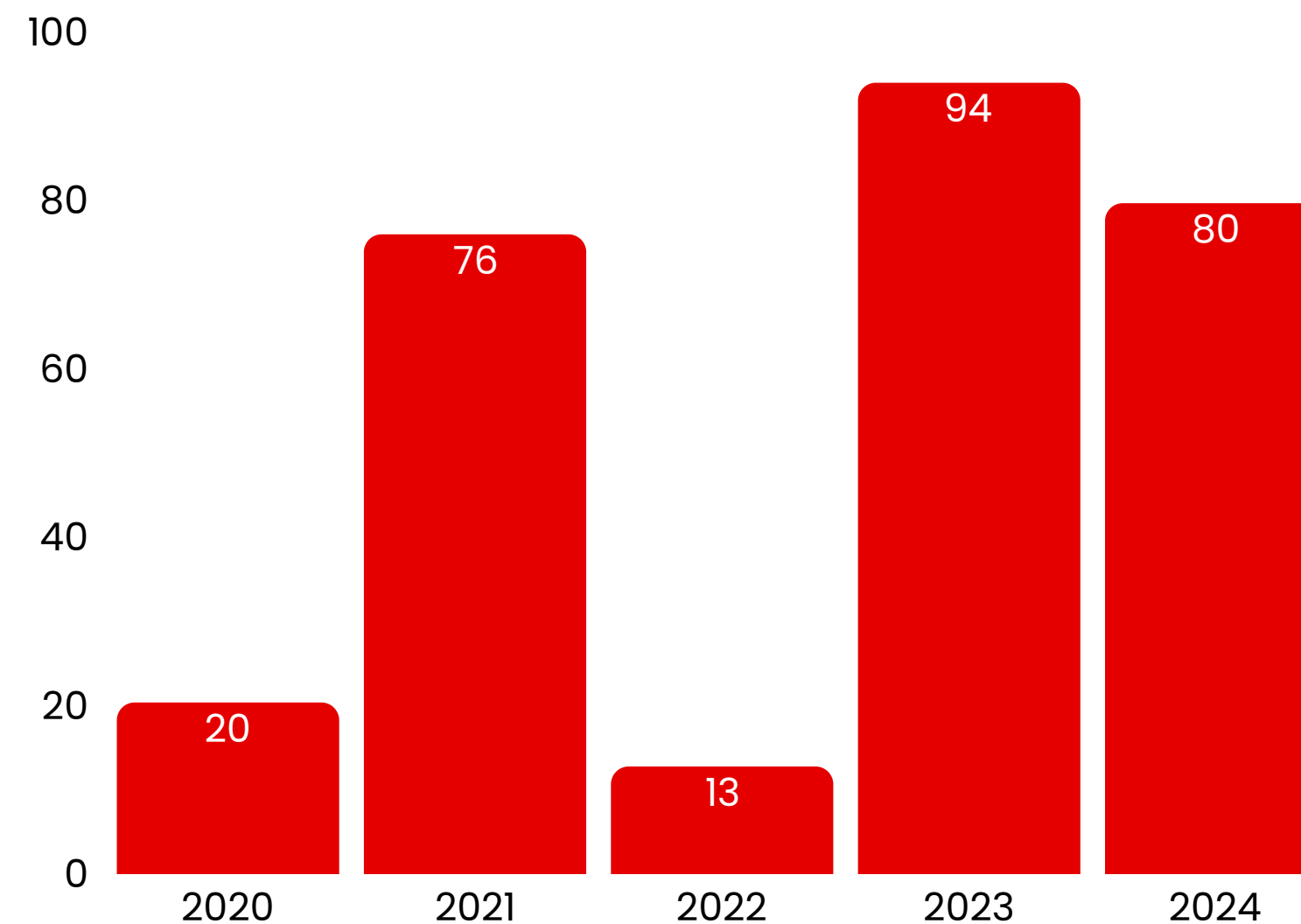




Global Investment

Total Funding (Millions \$)

- Funding in biochar startups has surged dramatically since 2020: from \$20.3M in 2020 to \$93.9M in 2023.
- 2023 was the strongest year on record, suggesting high investor interest in carbon removal & regenerative agriculture

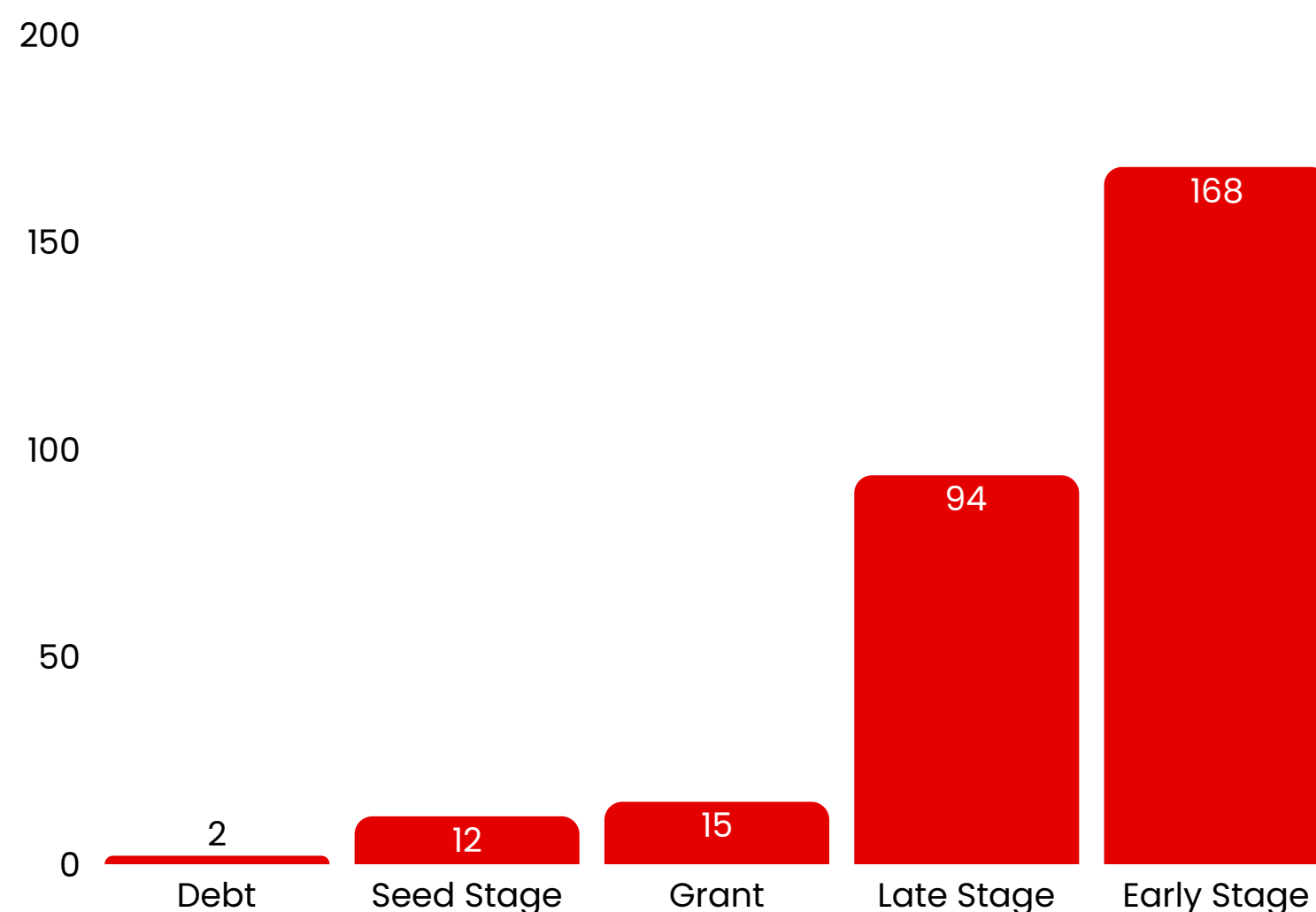


SOURCE- TRACXN





Biochar Startup Funding by Stage



- The highest funding is in early-stage startups, indicating that most companies are still building core technology, validating reactors, and proving carbon removal pathways. Investors are betting on technology development rather than mature scale.
- Almost no debt financing (\$2M) — biochar is not yet bankable. Debt requires predictable cashflows.

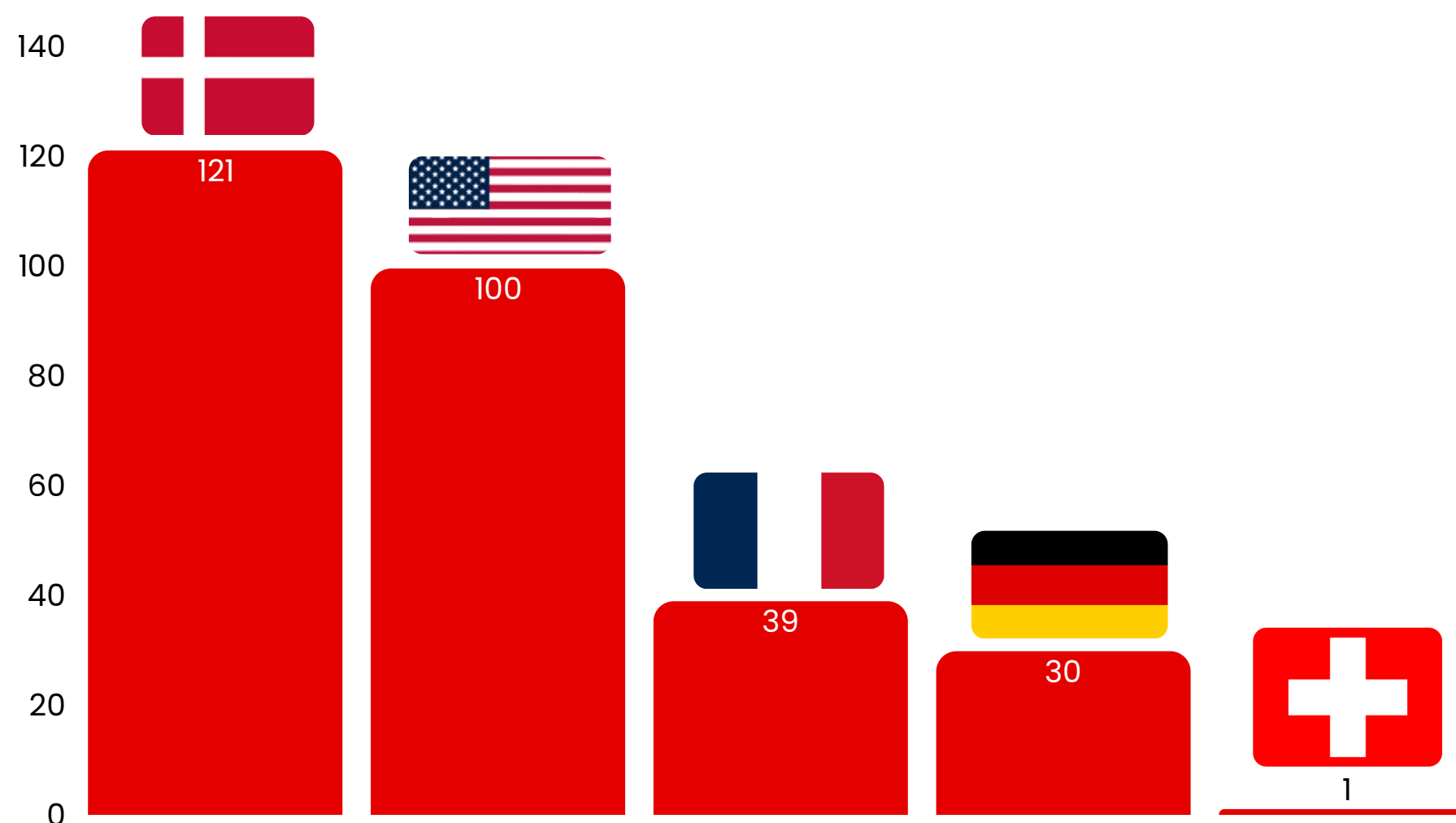
The tiny amount of debt shows:

- Biochar unit economics are not stable enough
- Carbon-credit revenues are still volatile
- Banks and climate infra lenders are not ready





Where Funding Flows in Biochar (Million \$)



- In the last 10 years, Biochar startups in Denmark have received the highest funding among all countries – \$121M. United States follows with \$99.5M and France with \$38.9M. Likely driven by Europe's aggressive net-zero policies and leadership in negative emissions tech.
- India does not appear yet in this list, despite having huge untapped agri-residue potential –highlighting a clear funding gap and a major opportunity for climate-tech investors.





Why Does Denmark Lead Global Biochar Funding?



A) Denmark Has a National Pyrolysis Strategy (Government-Led)

Denmark is the only country with a formal, government-backed pyrolysis program, recognizing biochar as a key negative-emissions technology.

B) Subsidies for Pyrolysis Heat (Massive Advantage)

Denmark subsidises pyrolysis heat when used in district heating networks. This makes Danish pyrolysis plants profitable even without carbon credits. No other country offers this level of direct economic support.





Why Does Denmark Lead Global Biochar Funding?



C) Mature Carbon Market + Compliance Alignment

Denmark aligns biochar with the EU's CRCF (Carbon Removal Certification Framework), which treats biochar as a future compliance-grade CDR pathway. This attracts institutional climate capital and guarantees long-term buyers.

D) Strong Industrial Players + R&D Ecosystem

Denmark has some of the world's most advanced biochar companies:

- Stiesdal SkyClean (flagship pyrolysis infra)
- MASH Makes
- Other carbon tech R&D clusters

Investors back Denmark because it has both technology and national demand (district heating, agriculture, materials).





India – Top Companies

Varaha



Employs high-temperature pyrolysis in specialized kilns to convert invasive woody biomass in the Indian states of Gujarat and Rajasthan (such as *Prosopis juliflora*) into stable biochar with high permanence.



*The *Prosopis juliflora* is an invasive species that has overrun Gujarat's Banni grasslands, forming dense thickets that suppress native plants, deplete groundwater, and reduce biodiversity. Converting its biomass to biochar via pyrolysis helps eradicate the plant in an eco-friendly way by removing the need to burn it, restores ecosystems and, at the same time, sequesters carbon long-term.*

Image credit: www.landerprosopis.com

➤➤➤ At A Glance

- Founding Year: 2022
- HQ: Gurugram, Haryana
- Stage: Series B
- Total Funds Raised: \$ 42.7M





India – Top Companies



MASH Makes



An Indo-Dutch company, MASH Makes converts agricultural waste into bio-oil, hydrogen and biochar via slow pyrolysis. The oil and gas products can be used to generate electricity, while biochar serves as a means of carbon sequestration and can be added to soil as a fertilizer.



MASH Makes recently launched phase 2 at their biochar processing facility in Udupi, Karnataka. With this upgrade, the facility will double its annual biochar production to 7,000 tons of biofuel and 14,000 tons of biochar. The corresponding construction and development is expected to create hundreds of additional jobs, further stimulating the local economy.

Image credit: Times of India

>>> At A Glance

- Founding Year: 2015
- HQ: Mumbai, Maharashtra
- Stage: Series A
- Total Funds Raised: \$ 17.8M





India – Top Companies



Alt Carbon



Produces premium biochar from agricultural waste (sugarcane bagasse, cotton stalks, etc.) in West Bengal and Odisha. Supplies biochar to large regenerative-agriculture projects and international carbon-credit buyers (Microsoft, Shopify). Operates one of the largest single-site biochar facilities in India.

>>> At A Glance

- Founding Year: 2023
- HQ: Kolkata, West Bengal
- Stage: Seed
- Total Funds Raised: \$ 12.5M



Alt Carbon Raised \$12 million in seed funding in 2025 to scale biochar-based carbon removal infrastructure across India, Southeast Asia, and Sub-Saharan Africa. They develop full-stack solutions including farmer partnerships, advanced pyrolysis units, and a software platform for transparent MRV using satellite imagery, IoT sensors, and blockchain-verified credits.

Image credit: techresearchonline.com





India – Top Companies

Equilibrium



Building scalable, high-integrity nature-based carbon removal projects across the Global South. It combines carbon science, technology, and community partnerships to regenerate degraded land and deliver durable, verifiable carbon credits.

>>> At A Glance

- ▶ Founding Year: 2024
- ▶ HQ: Bengaluru, Karnataka
- ▶ Stage: Seed
- ▶ Total Funds Raised: \$ 3M



With \$3M seed funding raised in September 2025, Equilibrium is scaling its biochar operations across nine Indian states, integrating agricultural waste from regenerative projects into high-purity production. It customizes enriched blends with NGOs and FPOs through multi-crop trials, targeting 20M tonnes of CDR over 120,000 hectares.



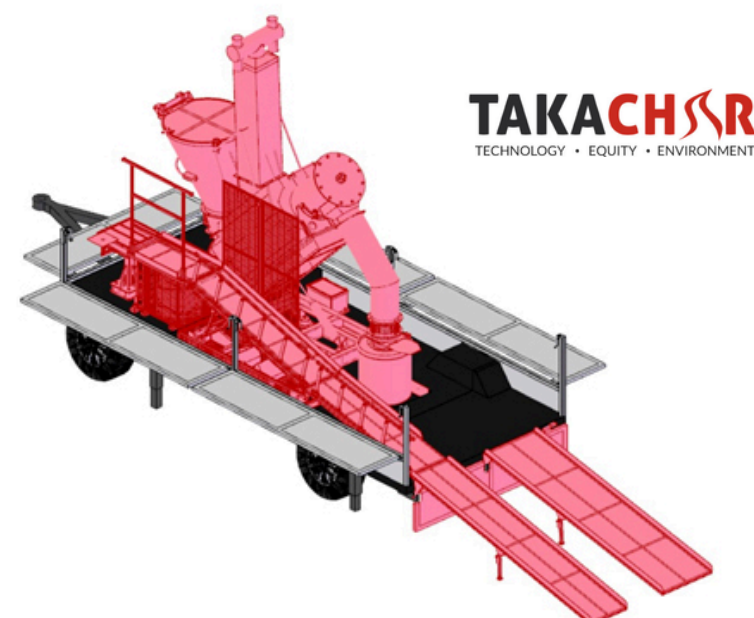


India – Top Companies

Takachar



Founded in New Delhi and with dual headquarters in both Delhi and Boston, Takachar delivers small-scale, low-cost, portable reactors enabled by IoT controls and hardware for on-site processing capable of converting loose, wet, bulky agricultural and forest residues (like rice husks) into biochar.



>>> At A Glance

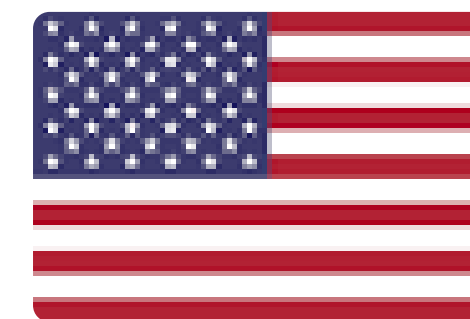
- Founding Year: 2018
- HQ: Boston, Massachusetts & New Delhi, India
- Stage: Growth/Scale-Up
- Total Funds Raised: \$ 1.94M

Right. A schematic depicting Takachar's flagship biochar production technology, the Takavator. It can process a wide variety of crop and forest residues and has a relatively low power requirement. Portable versions of this technology enable on-site processing and cut transportation costs.





United States of America– Top Companies



Applied Carbon



Develop mobile biochar production technologies which enable the conversion of agricultural residue into biochar on-site, eliminating the need for collection and transport.

>>>> At A Glance

- Founding Year: 2020
- HQ: Houston, Texas
- Stage: Series A
- Total Funds Raised: \$ 41.6M

Myno Carbon



Operate Carbon Removal Facilities (CRFs) that can convert up to ~40% of feedstock biomass carbon into a highly stable form of biochar called "inertinite biochar". This is a highly durable and stable form of biochar capable of sequestering carbon for over 1,000 years.

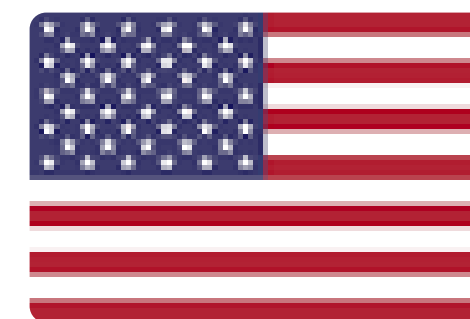
>>>> At A Glance

- Founding Year: 2020
- HQ: Bainbridge, Washington
- Stage: Series A
- Total Funds Raised: \$ 5.12M





United States of America – Top Companies



Terraton



Provide a "business-in-a-box" platform for creating biochar from agricultural waste, helping agribusinesses launch CDR facilities by handling financing, equipment, operations software (C-ERP), and selling verified carbon credits to buyers.

>>> At A Glance

- Founding Year: 2024
- HQ: San Francisco, California
- Stage: Seed
- Total Funds Raised: \$ 11.5M

Carbo Culture



Founded by a Finnish-American duo that met in the Silicon Valley, Carbo Culture specializes in the production of biochar from agricultural and horticultural waste/residue, such as nutshells from orchards.

>>> At A Glance

- Founding Year: 2016
- HQ: Woodside, California
- Stage: Series A
- Total Funds Raised: \$ 24.9M





Denmark– Top Companies

Klimate.co



Provide a platform for high-quality, verifiable carbon removal portfolios and focus on scaling carbon removal by selling portfolios of carbon removal credits from diverse projects (which include biochar production) to corporate buyers.

AquaGreen



Deploy patented steam drying and pyrolysis technology to convert wet sewage sludge and other biomass into biochar, while recovering renewable energy and removing pollutants like PFAS and microplastics



>>>At A Glance

- Founding Year: 2020
- HQ: Copenhagen, Denmark
- Stage: Seed
- Total Funds Raised: \$ 4.68M

>>>At A Glance

- Founding Year: 2014
- HQ: Roskilde, Denmark
- Stage: Series B
- Total Funds Raised: \$ 22.1M





Denmark— Top Companies

Stiesdal



Deploying industrial-scale pyrolysis technology that converts agricultural and forestry residues into biochar for long-term carbon storage while also producing renewable energy fuels and gases, effectively combining carbon removal with bioenergy value streams



>>> At A Glance

- Founding Year: 2016
- HQ: Odense, Denmark
- Stage: Series C
- Total Funds Raised: \$ 121M



The SkyClean process developed by Stiesdal converts approximately 50% of its biomass feedstock into biochar, with the remaining half being converted to bio-oil/gas.

The gas typically finds use as fuel in the heat supply industry, while the bio-oil can be further refined into fuel for the transport sector.





Germany– Top Companies

Novocarbo



Specialize in operating carbon removal parks that produce biochar and generate climate-neutral heat, which is offered as a "heat-as-a-service" solution. They plan to build up to 200 carbon removal parks across Europe by 2033.



>>>> At A Glance

- Founding Year: 2017
- HQ: Hamburg, Germany
- Stage: Series B
- Total Funds Raised: \$ 27.3M

Autarkize



Use patented pyrolysis technology to convert organic waste into renewable gas and high-quality biochar. The gas is used as a climate-neutral energy source.

>>>> At A Glance

- Founding Year: 2022
- HQ: Pfronten, Germany
- Stage: Seed
- Total Funds Raised: \$ 2.49M





Germany— Top Companies



PYREG GmbH



Design and manufacture high-tech machines that use patented pyrolysis technology to convert organic waste into high-quality biochar and renewable energy, thus helping create a circular economy by turning waste into a carbon sink and fertilizer.

>>> At A Glance

- Founding Year: 2009
- HQ: Dorth, Germany
- Stage: Growth/Scale
- Total Funds Raised: *Undisclosed*

Circular Carbon



They build and operate plants that transform waste (such as (like nut shells, wood scraps and food waste) into biochar, renewable energy in the form of heat/syngas and CDR credits.

>>> At A Glance

- Founding Year: 2018
- HQ: Hamburg, Germany
- Stage: Early/Seed
- Total Funds Raised: \$ 5.32M





France— Top Companies

NetZero

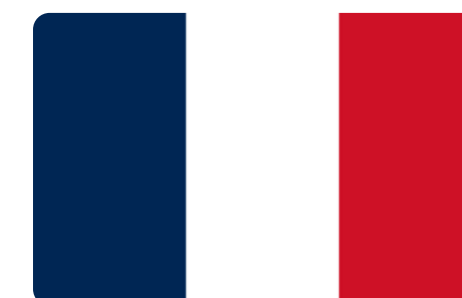


Operate biochar production plants that process agricultural waste (such as coffee-processing residues) from local farmers in countries like Cameroon and Brazil.

Miraïa



Use a continuous, vertical pyrolysis process to thermally decompose waste wood from sustainably managed forests and processing industries, to produce biochar and renewable energy in the form of syngas.



>>> At A Glance

- Founding Year: 2021
- HQ: Paris, France
- Stage: Series A
- Total Funds Raised: \$ 38.9M

>>> At A Glance

- Founding Year: 2023
- HQ: Toulouse, France
- Stage: Early/Seed
- Total Funds Raised: \$ 1M+





Switzerland– Top Companies



Cotierra



Operate decentralized pyrolysis reactors on coffee farms to convert coffee residues to premium biochar. Unique for having achieved farm-level scalability in the tropics, while delivering co-benefits such as resilient supply chains and emission cuts.

BCHAR



Provide automated, turn-key hardware systems that include built-in software for Measurement, Reporting, and Verification (MRV) of carbon removal. They primarily target the agriculture and food sectors in the Global South and aim to scale globally.

>>>> At A Glance

- Founding Year: 2023
- HQ: Zurich, Switzerland
- Stage: Seed
- Total Funds Raised: \$ 1M

>>>> At A Glance

- Founding Year: 2023
- HQ: Zurich, Switzerland
- Stage: Early/Seed
- Total Funds Raised: \$ 41.4K





REGULATORY LANDSCAPE





European Union – CRCF + EBC (Most Advanced Framework)



1) EU CRCF – Carbon Removals & Carbon Farming Regulation

- The EU has adopted the Carbon Removals and Carbon Farming (CRCF) Regulation, a voluntary EU-wide certification framework for:
 - Permanent carbon removals
 - Carbon farming
 - Carbon storage in products.
- Under CRCF, the Commission is developing specific methodologies, including a biochar CDR methodology:
 - Only the stable fraction of biochar can be credited as “permanent” carbon.
 - Clear rules on analytical methods, sampling and contaminant thresholds. Activity period reduced from 10 → 5 years to update rules as science improves.

Implication:

EU is on track to have the world’s first semi-regulatory biochar CDR standard, which will likely underpin future compliance markets and national schemes.





European Union – CRCF + EBC (Most Advanced Framework)



2) European Biochar Certificate (EBC)

- EBC is an industry-driven but widely recognised quality assurance system for biochar products:
 - Sets sustainability criteria for feedstock and production.
 - Defines thresholds for contaminants, H:C ratio, ash, nutrient content, etc.
- Many EU buyers (especially construction, filtration, agriculture) require EBC-certified biochar as a condition for procurement.

Implication:

Even before CRCF credits, EBC has effectively regulated biochar quality in Europe; CRCF now layers carbon removal certification on top.





India – Early Policy Stage, Big Opportunity, No Dedicated Biochar Law (Yet)



India has huge feedstock potential, but no single, explicit biochar regulation. Instead, biochar sits at the intersection of:

- Organic farming & soil health policies
- Crop-residue burning / air-pollution measures
- Waste-to-wealth & circular economy schemes
- Emerging carbon market (CCTS)

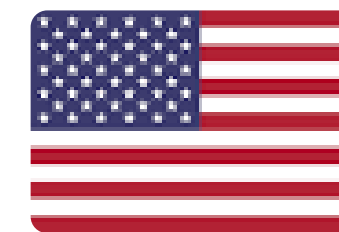


Image credit: MASH Makes





United States – 45Q, IRA & Emerging Biochar Signals



The US does not yet have a federal biochar-specific regulation, but several policies indirectly support biochar CDR.

45Q Tax Credit & IRA

- The Inflation Reduction Act (IRA) and earlier legislation expanded 45Q tax credits:
- Up to \$85/tCO₂ for geologic storage and \$180/tCO₂ for DAC, with funding for CO₂ transport & storage infra.
- Current 45Q is mainly designed for CCS & DAC, but there is active policy discussion about expanding carbon management incentives to diverse CDR methods including biochar.

Proposed Forest Residue / Biochar Credits

- A 2025 US Senate bill proposes a tax credit for using forest residues for carbon removal, which could cover biochar from wildfire mitigation residues

Implication:

The US framework is CDR-heavy but not biochar-specific; biochar projects mainly rely on voluntary standards (Puro/EBC) and corporate buyers, with future upside if 45Q or new credits explicitly include biochar.





Denmark – National Pyrolysis Strategy & Biochar Subsidy (World Leader)



Denmark is the clearest example of a country turning biochar into climate infrastructure:

- In 2024, Denmark agreed a tripartite green tax reform + agriculture deal which includes:
- A DKK ~10 billion ($\approx$ €1.34B) subsidy scheme for biochar production from 2027, paid per tonne of CO₂ stored.
- The government has also published a pyrolysis strategy to accelerate agricultural biochar adoption and establish a market for CCUS with biochar.
- Biochar heat can be sold into district heating networks, and policy recognises technologies like Stiesdal's SkyClean as important for Denmark's 2030 targets.

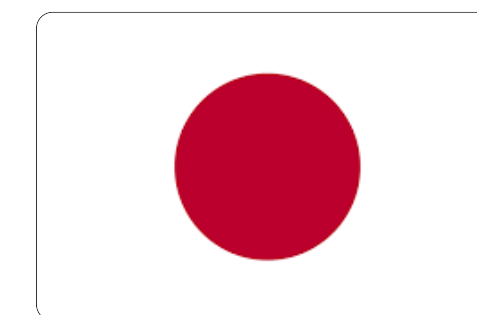
Denmark is the only country with a dedicated biochar subsidy per tonne of CO₂ stored– this is why so much capital has flowed into Danish pyrolysis.





Japan

- The Ministry of Agriculture, Forestry and Fisheries has provided subsidies for biochar production and application as part of climate-smart agriculture pilots.
- Japan is also developing a biochar methodology under the Joint Crediting Mechanism (JCM) for international offset projects.



Australia

- Australia's ACCU (Australia's Australian Carbon Credit Unit) Scheme (ex-ERF/CFI) is the country's main regulated carbon market; projects can earn ACCUs for recognised methodologies
- The Australian & New Zealand Biochar Industry Group (ANZBI) drafted an Australian Biochar for Soils Standard, providing technical and quality guidance for biochar as a soil amendment.





Brazil

- Brazil passed a Carbon Market Law establishing the national ETS (SBCE), with phased implementation and an interim carbon market secretariat now in place



Summary

Different countries are at different stages of biochar adoption, with the European Union (and Denmark in particular) emerging as a global leader. This is thanks, in large part, to their already mature clean energy and sustainability market.

There is, however, immense potential at a global level. Countries like the US and India are gradually amping up their involvement in the biochar market at a policy level, with Japan, Australia and Brazil not far behind.





KEY TAKEAWAYS FOR STAKEHOLDERS





1) INVESTORS

1. Decentralised and Cooperative Approaches Reduce Operational Risk
2. Farmer Economics Must Be Central to the Business Model
3. Incentive-Aligned Models Scale Faster Than Awareness-Driven Approaches
4. Carbon Yield and MRV Integrity Depend on Practical On-Ground Adoption
5. Models Dependent on Future Policy or High Credit Prices Carry Elevated Risk
6. Technology Ruggedness and Efficiency Are the Real Moats
7. Multi-Stream Revenue Models Enhance Financial Resilience
8. Industrial Biochar Applications Unlock Larger and More Stable Markets
9. Geographic and Policy Alignment Significantly Influence Profitability
10. Localised Feedstock Ecosystems Strengthen Supply-Chain Defensibility





2) POLICYMAKERS

1. Urgent Need for National Biochar Policy

India lacks a unified regulatory framework classifying biochar under fertilizer or carbon removal categories. Integrating it into FCO, GOBARdhan, and NMSA can mainstream adoption.

2. Incentivize Local Feedstock Use

Subsidies for mobile pyrolysis, residue collection hubs, and digital MRV can address stubble burning while creating carbon-negative rural industries.

3. Mandate Carbon Quality and MRV Standards

Establish India-specific standards akin to the European Biochar Certificate (EBC) and Puro.Earth methodology to ensure credibility in both domestic and export carbon markets.

4. Leverage Public-Private Partnerships

State-backed programs can co-invest in biochar hubs, MRV infrastructure, and rural entrepreneurship similar to how RDF has been mainstreamed in cement.





3) RESEARCH BODIES

1. Bridge Data and Deployment Gaps

Despite 12,000+ papers on biochar, fewer than 1% involve multi-year, real-field studies. India's universities and ICAR-KVKs can fill this void through 3–5-year longitudinal trials.

2. Focus on Feedstock Standardization

Research practical, region-specific preprocessing protocols for heterogeneous agricultural waste— beyond theoretical cellulose/lignin ratios.

3. Soil Microbiome and Toxicity Studies

Long-term work on biochar–microbe interactions, nutrient immobilization, and potential PAH contamination remains sparse and critical for scaling safely.

4. Quantification of Carbon Credits

Develop low-cost field-based tools and MRV frameworks for carbon content verification, ensuring accurate sequestration accounting and enabling smallholder inclusion.

5. Cross-Sector R&D

Expand focus beyond agriculture into construction composites, battery materials, and wastewater filtration, collaborating with industry to evaluate techno-economic feasibility.





INVESTOR THESIS

1. Farmer Economics Must Be Central to the Business Model

The upstream supply of biomass is entirely controlled by farmers and smallholders, whose decisions are governed by short-term economic survival rather than long-term environmental considerations.

Any model that increases a farmer's cost, labour requirements, or risk exposure will face adoption barriers. Investors should prioritise companies that integrate farmer-friendly economics— such as residue purchase mechanisms, shared savings, local processing incentives, or revenue-sharing from carbon credits— to ensure consistent feedstock supply at scale.

2. Decentralised and Cooperative Approaches Reduce Operational Risk

Centralised infrastructure often fails in regions with fragmented landholding and dispersed biomass. Models leveraging decentralised pyrolysis units, village-level deployment, farmer-producer organisations (FPOs), or cooperative ownership reduce logistics cost, improve feedstock reliability, and enhance community buy-in.

For investors, such models offer lower execution risk, faster deployment cycles, and more resilient unit economics, especially in India and other Global South markets





INVESTOR THESIS

3. Incentive-Aligned Models Scale Faster Than Awareness-Driven Approaches

On-ground evidence in India shows that awareness campaigns, training sessions, and compliance-based interventions rarely shift behaviour if they impose additional cost or effort on farmers.

Scalable biochar ventures must embed economic incentives within their solution. Business models that reduce operational costs for farmers, eliminate labour burdens, or offer guaranteed financial benefits result in materially higher adoption and predictable carbon output— fundamentally improving the bankability of the venture.

4. Carbon Yield and MRV Integrity Depend on Practical On-Ground Adoption

Technological capability alone does not guarantee carbon removals. Consistent MRV-quality results depend on whether farmers actually adopt the required practices at the right time, which in turn depends on economic viability.

Investors should evaluate whether the startup's solution ensures consistent biomass conversion, verifiable application, and tamper-proof data collection. Preference should be given to companies integrating digital MRV, farmer incentives, and field-level operational support.





INVESTOR THESIS

5. Models Dependent on Future Policy or High Credit Prices Carry Elevated Risk

India currently lacks a dedicated biochar subsidy, classification standard, or national crediting methodology. Ventures that assume favourable policy shifts or sustained high carbon prices without strong underlying economics face significant regulatory and market risk.

More resilient opportunities are those with diversified revenue streams– biochar products, carbon credits, heat or energy recovery, waste-management fees– and unit economics that remain viable even under conservative credit price scenarios.

6. Technology Ruggedness and Efficiency Are the Real Moats

In emerging markets, the most scalable companies are those that deliver robust, energy-efficient, and low-maintenance conversion systems rather than highly sophisticated or complex pyrolysis technologies. Metrics such as carbon-retention efficiency, autothermal performance, uptime reliability, and emissions control are critical indicators of technological strength.

For investors, the durability and operational simplicity of the solution are stronger predictors of scalability than technical novelty alone.





INVESTOR THESIS

7. Multi-Stream Revenue Models Enhance Financial Resilience

Global biochar companies are increasingly adopting integrated revenue models that combine biochar product sales, carbon removal credits, heat or syngas utilisation, and waste-management fees.

Startups dependent on a single revenue channel remain exposed to price volatility, verification delays, and seasonal demand fluctuations.

8. Industrial Biochar Applications Unlock Larger and More Stable Markets

Beyond agriculture, biochar is increasingly used in high-value industrial applications such as asphalt modification, construction materials, filtration media, composites, and activated carbon.

These sectors provide higher margins, larger offtake capacity, and more predictable demand.





INVESTOR THESIS

9. Geographic and Policy Alignment Significantly Influence Profitability

Profitability in the biochar sector is increasingly shaped by policy environments, heat-recovery incentives, biochar subsidies, waste-management regulations, and carbon-market integration.

Regions such as the EU and Denmark offer stronger economic conditions compared to markets where carbon credit access is uncertain.

10. Localised Feedstock Ecosystems Strengthen Supply-Chain Defensibility

Biochar ventures that build hyper-local biomass ecosystems—through FPO partnerships, cooperative sourcing networks, village-level collection models, or invasive-species utilisation—enjoy structurally lower logistics costs and reduced feedstock risk.





APPENDIX CASE STUDIES

SOURCE- MASHMAKES





1) Field Trial to Determine the Impact of Biochar on Irrigation Need

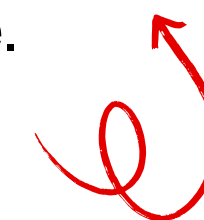
Problem

Wheat farmers face an uphill battle in India's Vidarbha region. Rainfall is unpredictable, groundwater is vanishing, and droughts are becoming more common. That makes it increasingly harder to grow food in this already dry landscape.

Experimental Setup

In the trial, wheat was grown under different irrigation levels— with and without biochar. The plots were irrigated and crop yields were measured and compared at the end of the trial period.

The results are discussed on the following page.





1) Field Trial to Determine the Impact of Biochar on Irrigation Need

Results

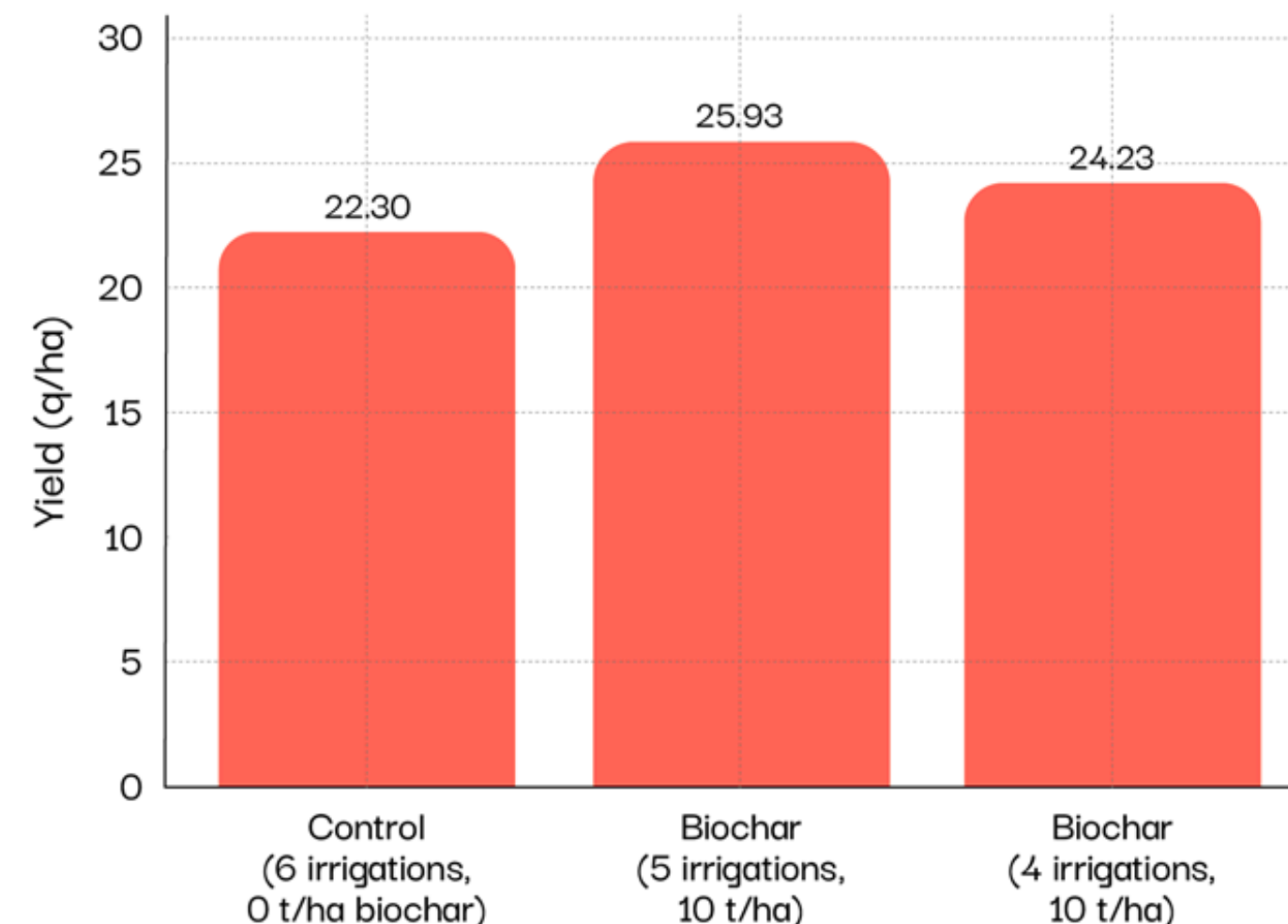
Some of the plots received fewer waterings but still outperformed the control fields, due to biochar. One treatment, for example, used one less irrigation than the control but produced a 16% higher yield.

Why it Works

Biochar acts like a sponge in the soil. It holds water longer, gives plant roots better access to nutrients, and creates a healthier growing environment- especially in hot, dry conditions like those in Vidarbha.

For wheat farmers struggling with water shortages, that means fewer irrigation rounds, stronger crops, and more stable harvests.

Wheat yield under different irrigation and biochar treatments





2) Field Trials to Determine Optimal Application Rates for Maximum Yields

Experimental Setup

MASH Makes researchers tested biochar on three staple crops in one of the toughest farming environments in India. The results are in: biochar can significantly boost crop yields, but only when used in the right amounts.

Results

- Wheat: Applying 2 tons of biochar per acre resulted in a 33.81% increase in seed weight and a 35.08% increase in biomass.
- Onions: The optimal biochar application was 4 tons per acre, which increased bulb weight by 36.24% and biomass by 26.31%.
- Chickpeas: At 2 tons per acre, seed weight increased by 27.44% and biomass by 21.86%.





2) Field Trials to Determine Optimal Application Rates for Maximum Yields

What's in it for the farmers?

The study showed that for farmers, biochar offers several key benefits:

1. Soil health and crop productivity: By enhancing soil structure and nutrient retention, biochar can lead to better yields and healthier crops over multiple years. Using biochar at an optimal rate (2 tons per acre) showed promising improvements in soil quality and crop yields in the trials.
2. More profits: Initial trials suggest that biochar can be an effective investment when used in moderate quantities, leading to a balance between input costs and crop yield benefits. Though a higher application rate didn't yield enough increase in crops like onions, a lower, optimised application has proven cost-effective for several other crops.
3. Long-Term Benefits: Biochar's effects last beyond just one planting season. The yield benefits extend up to three years. This can result in long-term gains that improve financial returns over time.



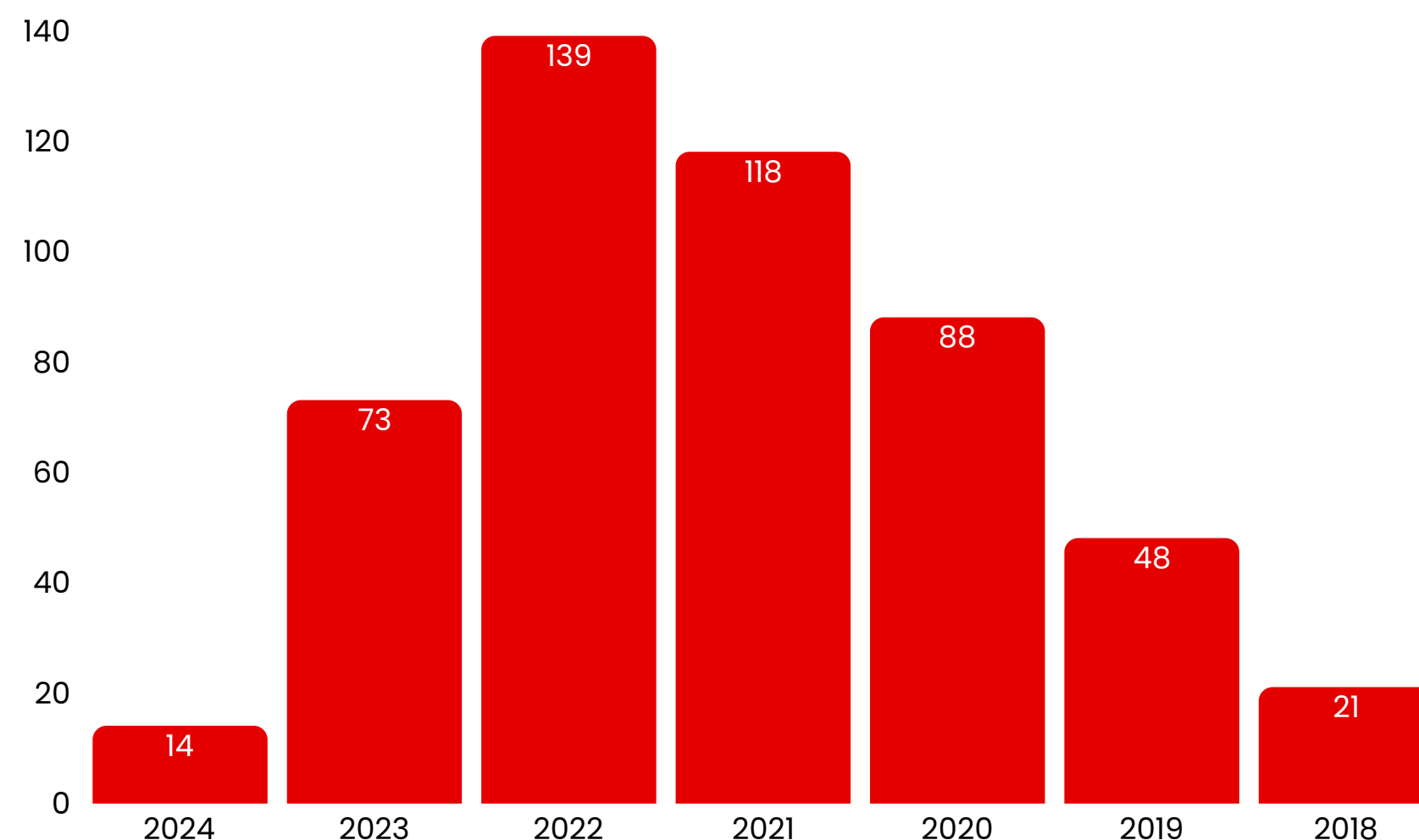


FUNDING IN CARBON CREDIT TRADING





Number of Companies Founded

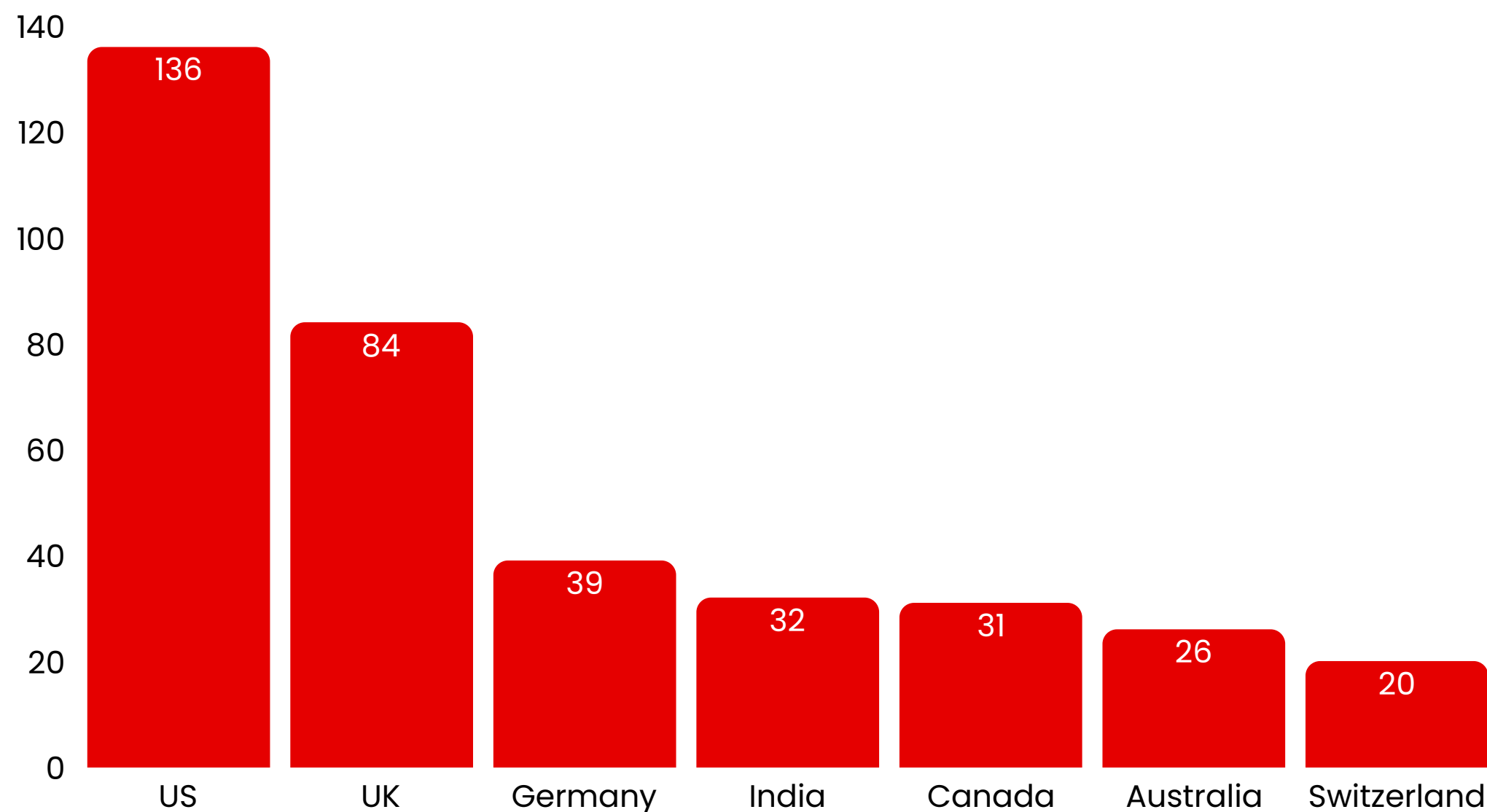


- The carbon credits sector saw explosive growth, with 118 companies in 2021 and 139 in 2022, driven by net-zero commitments, climate capital inflows, and the rise of high-integrity removals like biochar.
- Company formation dropped to 73 in 2023 and just 14 in 2024, reflecting market consolidation, tightening VC funding, and scrutiny on offset quality.





Companies Founded by Country

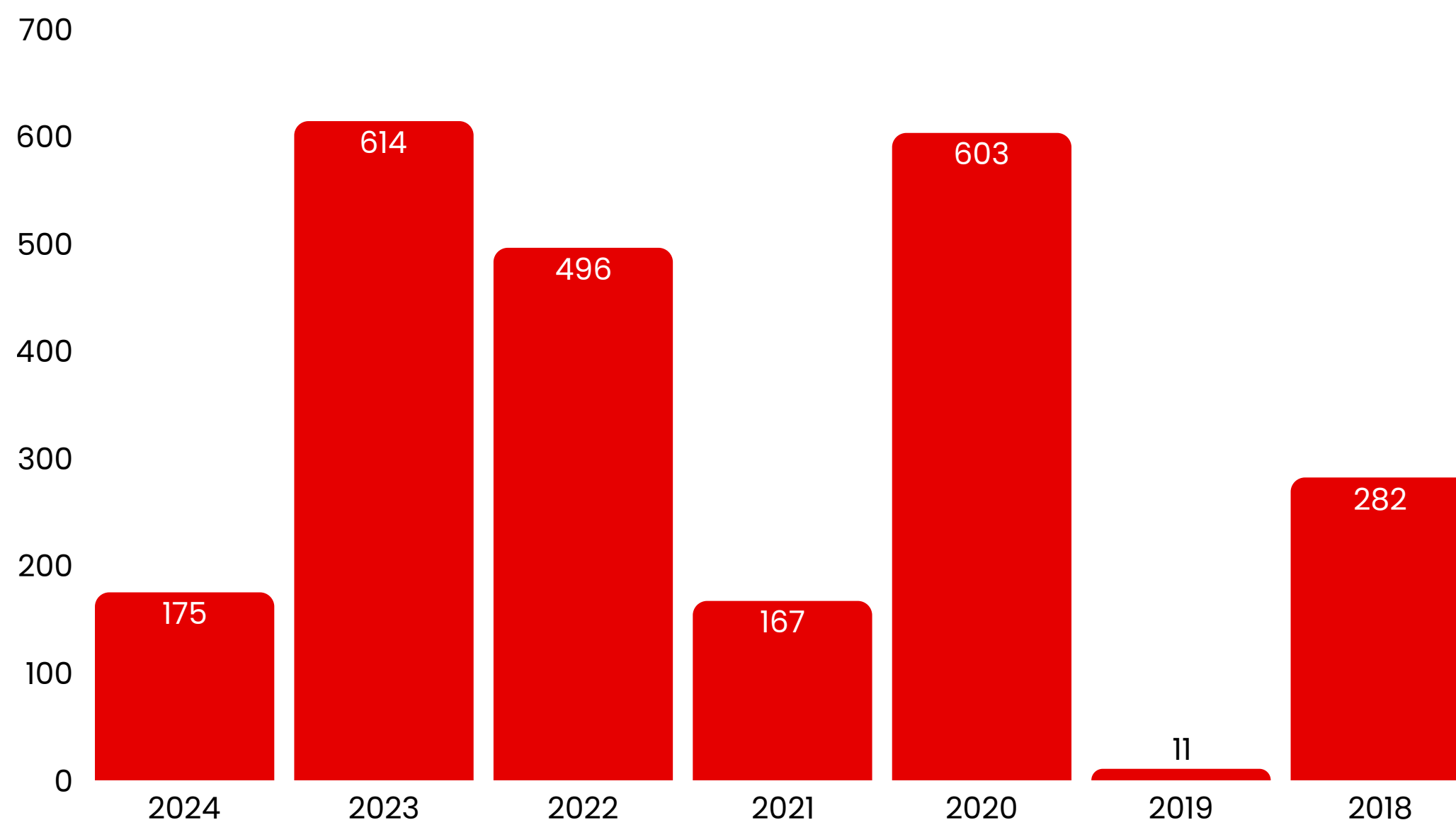


- The United States & UK dominate the carbon credit trading startup ecosystem – with many new platforms, marketplaces, and service providers enabling buyers and sellers to trade all types of carbon credits (including biochar).
- India ranks 4th – showing it has a growing pool of climate-tech startups building digital marketplaces, MRV tech, or bundled carbon services.
- Biochar credits are a small but growing segment within this wider carbon market – often bundled under “nature-based removal” credits.





Total Funding (Million \$)

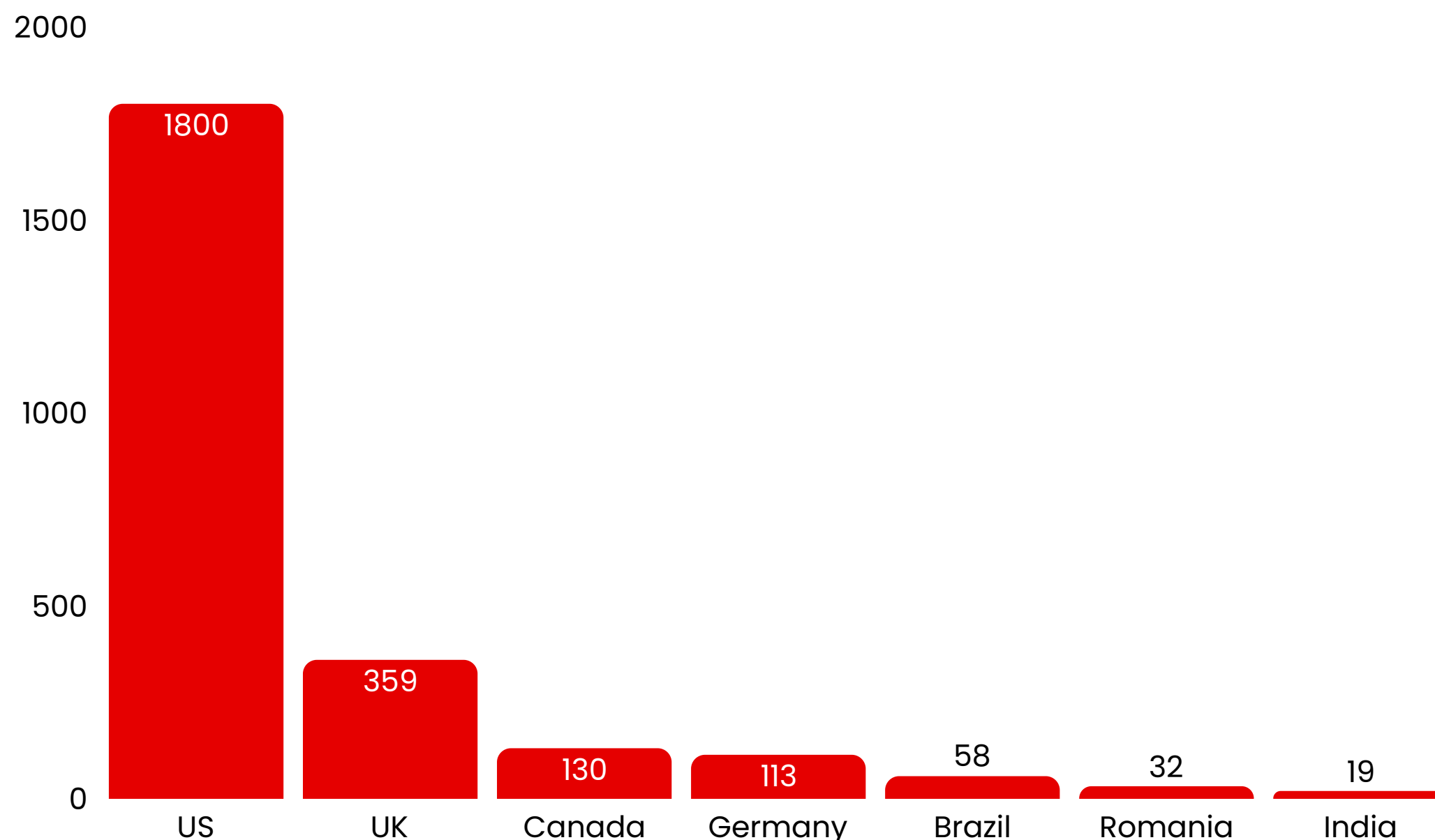


- Big funding spike in 2020–2023– Major jump from \$10.6M in 2019 → to \$603M in 2020, peaking at \$614M in 2023.
- This matches the global boom in voluntary carbon markets (VCM) when corporates ramped up net-zero pledges and demanded high-quality offsets.
- Gradual cooling in 2024–2025– Funding drops to \$175M in 2024 and \$75M so far in 2025 → showing VC caution, market corrections, and likely higher scrutiny on carbon credit quality.





Country-Wise Funding (Million \$)



- Funding is highly concentrated in the Global North (US + UK = ~85%+ of this list).
- Emerging economies like India have big feedstock potential but low investment for credible carbon credits infrastructure and biochar scale-up.
- Although India ranks 4th globally by number of biochar and carbon removal startups, most still struggle to secure sufficient funding for scaling up operations, implementing robust MRV systems, and generating export-quality carbon credits.





Biochar in Animal Feed

Biochar works mainly through physical and chemical adsorption, not as a nutrient. Its porous structure helps bind toxins and improves gut conditions.

1. Gut Health & Digestion

- Adsorbs toxins, mycotoxins, pathogens, and excess gases in the gut
- Improves microbial balance and rumen function
- Reduces diarrhea and digestive stress

2. Improved Feed Efficiency

- Better nutrient absorption → higher feed conversion ratio (FCR)
- Studies show improvements in:
 - Milk yield in cattle
 - Weight gain in poultry and pigs

3. Animal Health & Immunity

- Lower toxin load → reduced metabolic stress
- Reported reduction in veterinary interventions (antibiotics, anti-diarrheals)





Biochar in Animal Feed

Dosage & Application (Indicative)

- Typically 0.2–1% of dry feed weight
- Must be:
 - Food-grade / feed-grade biochar
 - Low in PAHs, heavy metals, ash
 - Often activated or finely milled

Key Challenges & Risks

- Quality variability across biochar sources
- Lack of standardized regulations in many countries
- Limited large-scale, long-term trials (especially in India)
- Needs species-specific validation

Cattle Type	Observed Benefits
Cattle & Buffalo	Better rumen health, milk yield stability, methane reduction
Poultry	Improved FCR, lower mortality, firmer droppings
Pigs	Better gut integrity, weight gain, reduced odor
Aquaculture	Water quality improvement, toxin adsorption

