

Investment Insights

Quarterly Investment Insights, Q4 2024

Notes on Coverage

- As part of our constant effort to develop a data set that reflects the cleantech world as we see it, we periodically review our Cleantech Taxonomy.
- We may make small adjustments in previous quarter numbers when our analysts uncover an older deal or obtain additional information as part of the ongoing research.



AGRICULTURE
& FOOD



ENERGY
& POWER



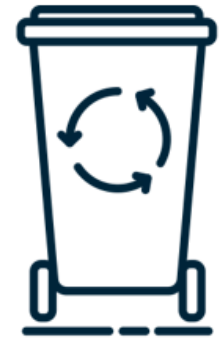
MATERIALS
& CHEMICALS



RESOURCES & ENVIRONMENT
MANAGEMENT



TRANSPORTATION
& LOGISTICS



WASTE & RECYCLING

← Enabling Technologies, Business Models and Themes →

Cleantech Quarterly Investment Update Webinar (February 6)

The market dynamics that will drive the pace of innovation roll-out in 2025 were on full display in Q4 of 2024.

The race to get a foot in the decarbonization door of the AI revolution is happening at full speed. This past quarter, we saw continued high activity in large-scale investments around data center stand-up & operations. Fusion saw a landmark quarter as well, as power-intensive industries begin planning for the 2030s and beyond.

The urgency of the AI market is seen in the materials & chemicals space as well, where novel semiconductors to reduce power consumption in chips continue to make strong showings in the investment numbers.

In 2025, look closely to the overlap between cleantech and defense, one of the first indicators to be observed is a renewed push to secure critical materials. Some innovators are positioning themselves for this wave of interest already.

We see some new sectors opening up ahead of schedule – aviation decarbonization had a breakout quarter with some shifts in regulation.

We hope you will join us for our Quarterly Investment Update Webinar on Q4 2024, to unpack these trends and more, on **February 6th at 11am Eastern (5PM CET)**.

Subscribers can register here: <https://cleantech.swoogo.com/Q4-QII-2024>



Anthony DeOrsey
Research Manager



Ian Hayton
Group Lead,
Materials &
Chemicals



Holly Stower
Group Lead,
Resources &
Environment



Selene Law
Senior Associate,
Energy & Power



Jack Ellis
Senior Associate,
Agriculture & Food



Nicole Cerulli
Associate,
Transportation &
Logistics



Alex Crutchfield
Associate, Resources
& Environmental
Management



Zainab Gilani
Associate,
Energy & Power



Parker Bovée
Associate, Waste &
Recycling



Buff López
Associate, Materials
& Chemicals



Sunena Gupta
Associate, Resources
& Environmental
Management

New i3 Feature: Living Value Chains

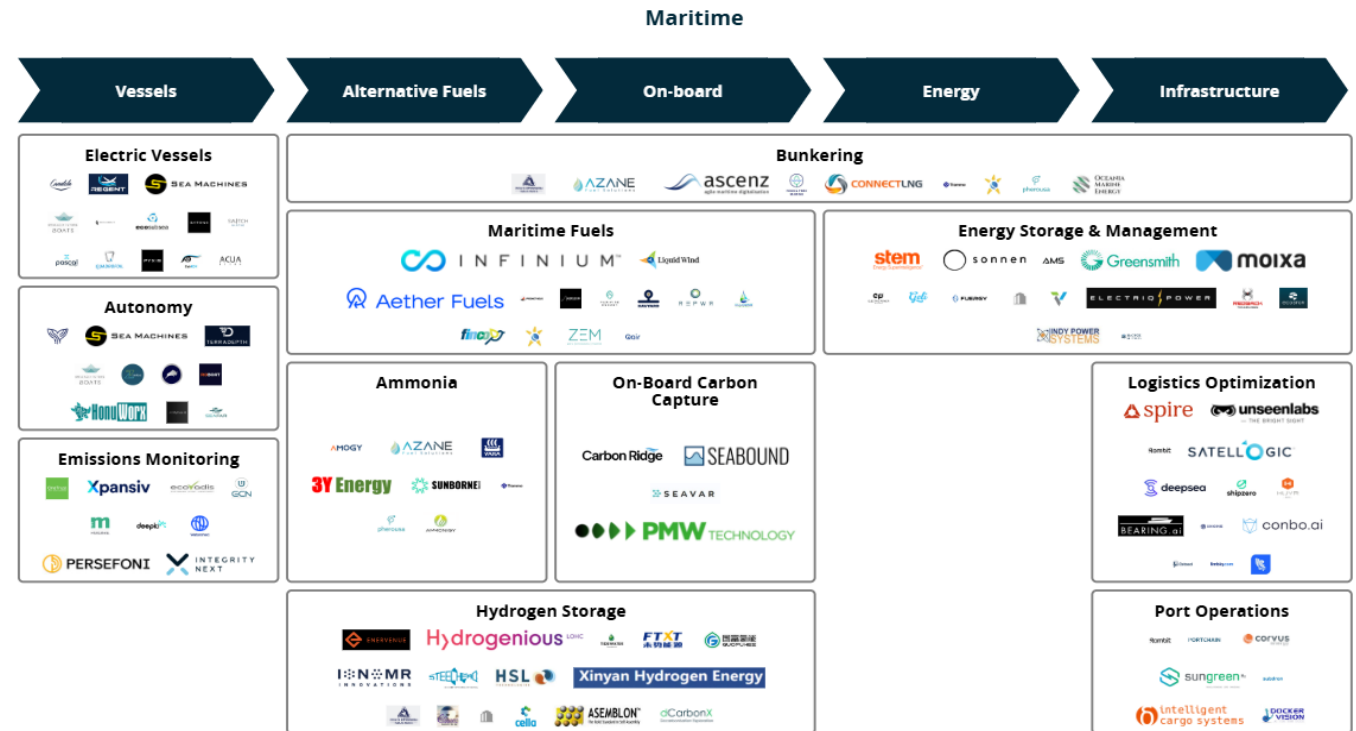
As part of work to update and modernise i3, this quarter will see the release of 'Living Value Chains' to the i3 platform.

- Value Chains featured in our research reports will start to appear on relevant sector pages, as well as organisation profiles
- Value chains will be 'live' - as companies are added to i3 or assigned relevant tags, this will be reflected in associated value chains in real time
- Geographical filtering of value chains on sector pages allows users to view supply of innovation in different regions

The tool enables us to quickly create custom value chains which can be exported in PowerPoint format for use in presentations. These can be customised, including for geography, Technology Readiness Level (TRL), and capital raised.

Living Value Chains

Geography **Value Chain Specific** All Africa Asia Pacific Central/South America Europe & Israel Middle East North America



2025 Q1 Research Schedule



Agriculture & Food

- Spotlight: Non-food Crops for Biofuels
- Spotlight: AI for Crop Science



Energy & Power

- Spotlight: Industrial Process Optimization
- Spotlight: Fusion – Novel Reactor Design



Materials & Chemicals

- Spotlight: Green Ammonia Production
- Spotlight: Green Cement Production



Resources & Environmental Management

- Insight: Geoengineering
- Spotlight: Earth Observation & Sensing



Transportation & Logistics

- Spotlight: Supply Chain Decarbonization – Materials Traceability



Waste & Recycling

- Insight: PFAS Treatment

Cross-cutting Cleantech Themes

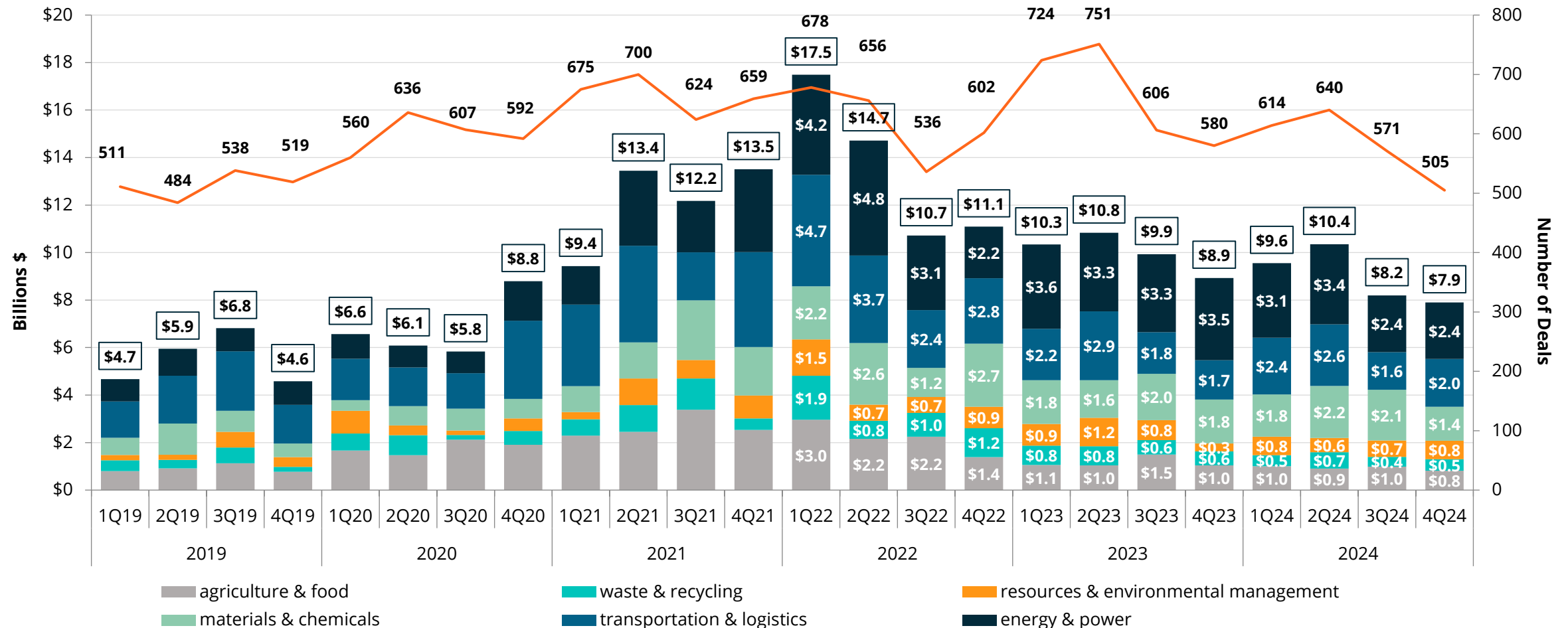
- AI Applications in Cleantech
- Climate- Related Insurance

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Cleantech Deal Amount and Volume: 4Q24

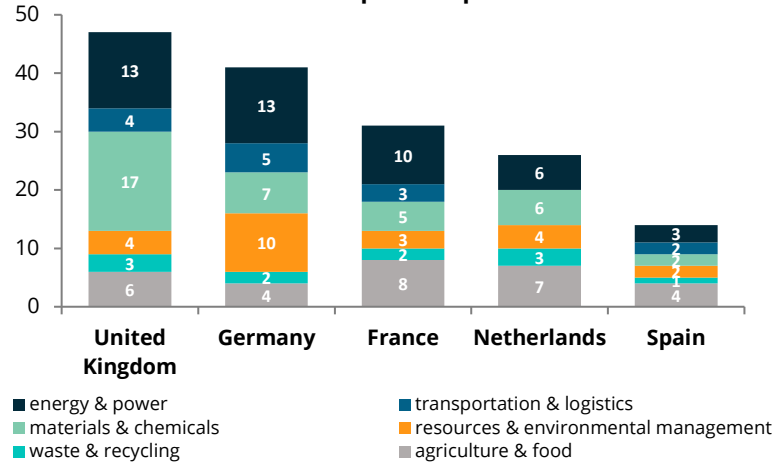
At a glance, venture activity looks quiet in the second half of 2024, as Q4 wraps up with \$7.9B raised across 505 deals. These funding lulls paint incomplete picture, however, as this quarter generated nine outlier rounds (over \$350M) bringing total funding to \$13.8B. Investments in high performing sectors *energy storage* and *electric vehicle (ev) charging* pulled back in 2H24 with the absence of mega rounds invested in 1H24, being surpassed by *buildings* (energy management systems) and *aviation* at the end of the year.



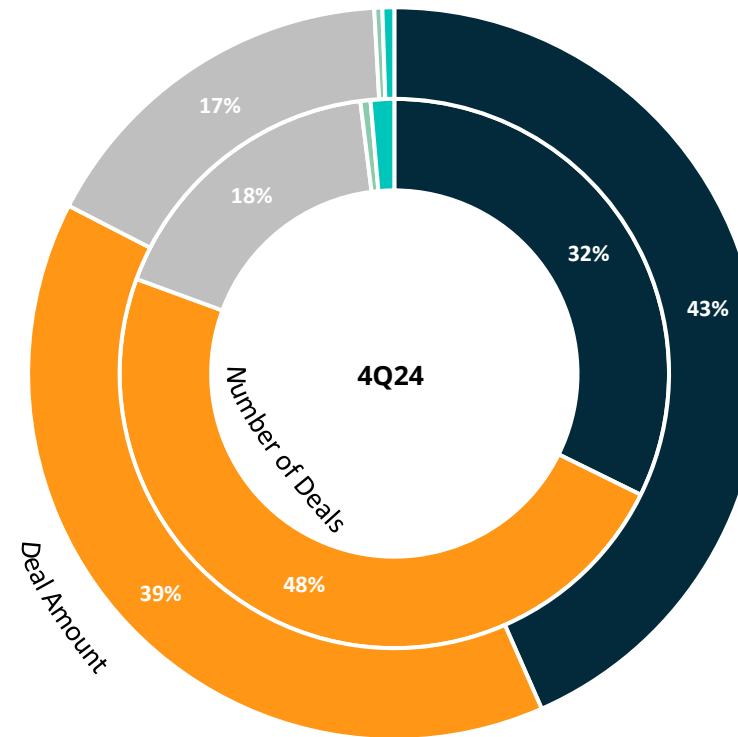
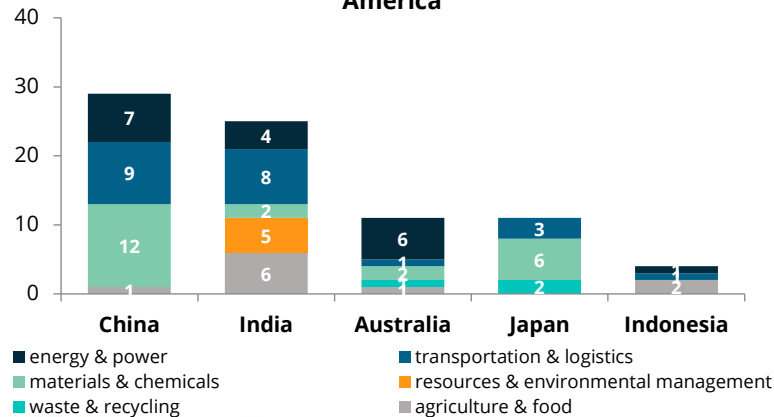
Cleantech Deal Volume by Geography: 4Q24

North America invested more dollars over fewer venture deals, holding seven of Q4's nine outlier rounds (above \$350M). Five of these rounds sat in *nuclear*, *energy efficient computing* and *buildings (data centers)*, reflecting the region's continued focus on sustainably powering rapid growth in AI-based technologies. Total funding and deal volume tapered off in emerging markets at the end of 2024; persisting high interest rates and geopolitical tensions hampering APAC's funding environment, especially at earlier stages.

Startups - Europe

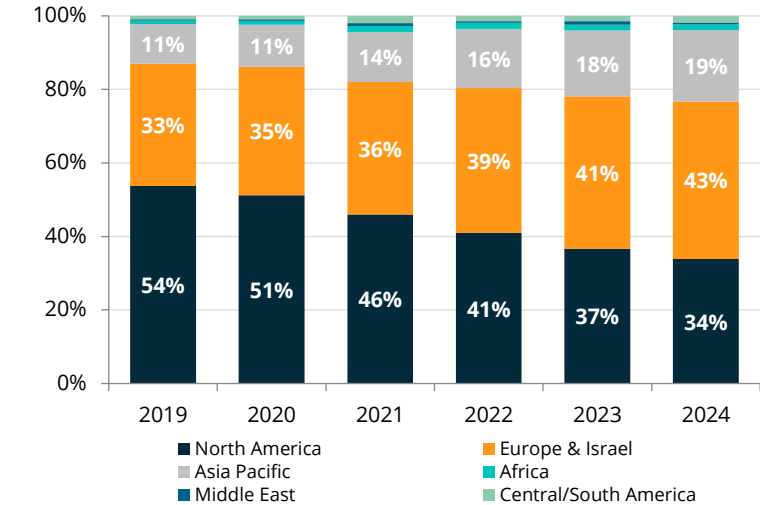


Startups - Asia Pacific, Middle East, South/Central America

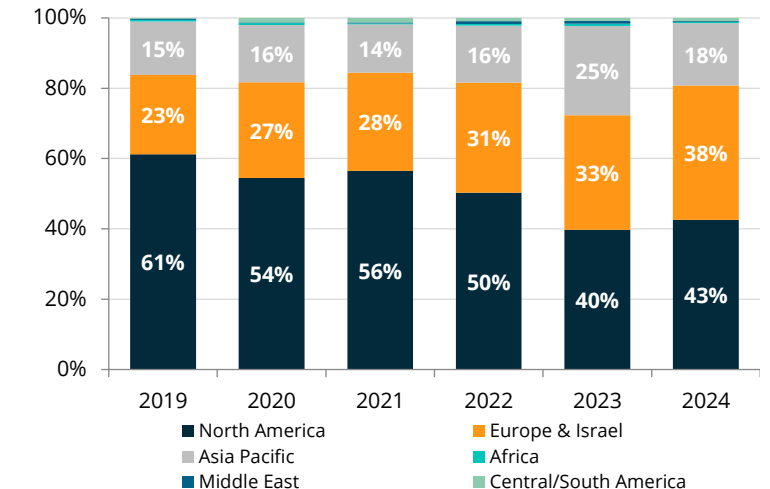


* Excludes outlier deals above \$350M

By Total Number of Deals

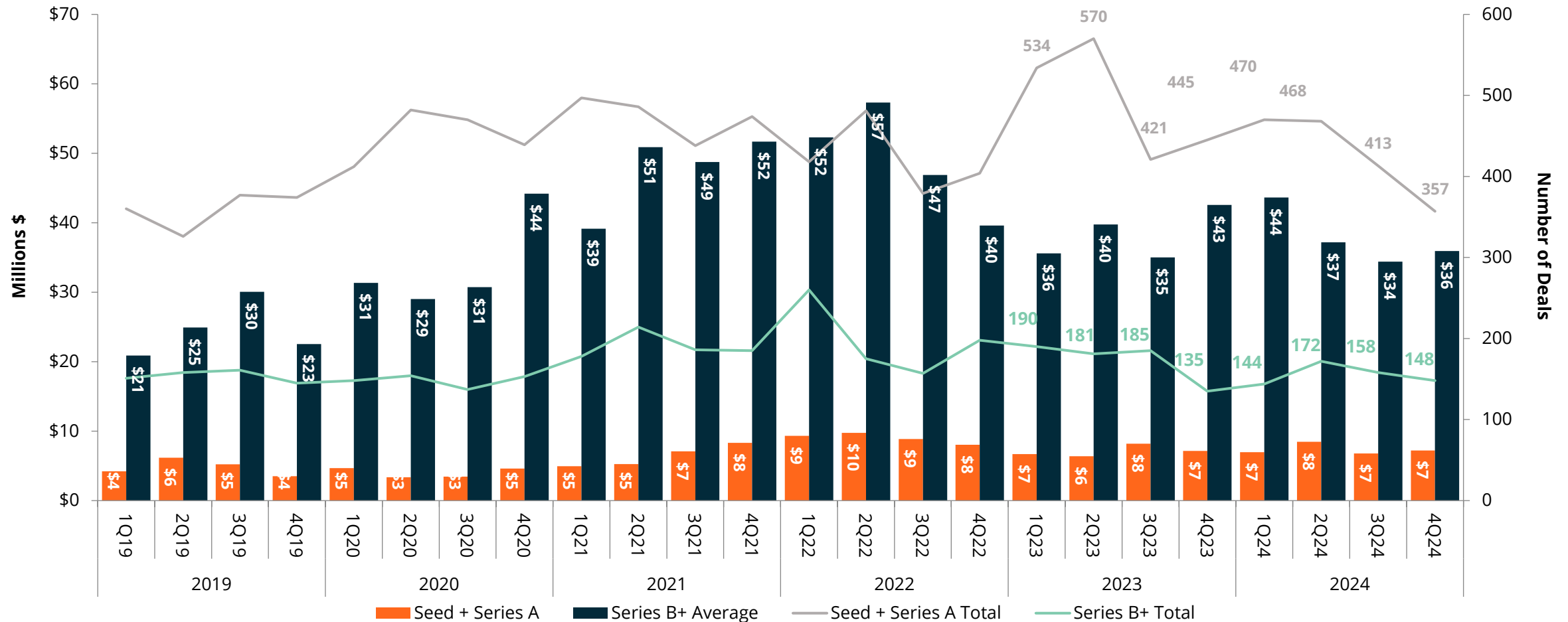


By Total Deal Amount



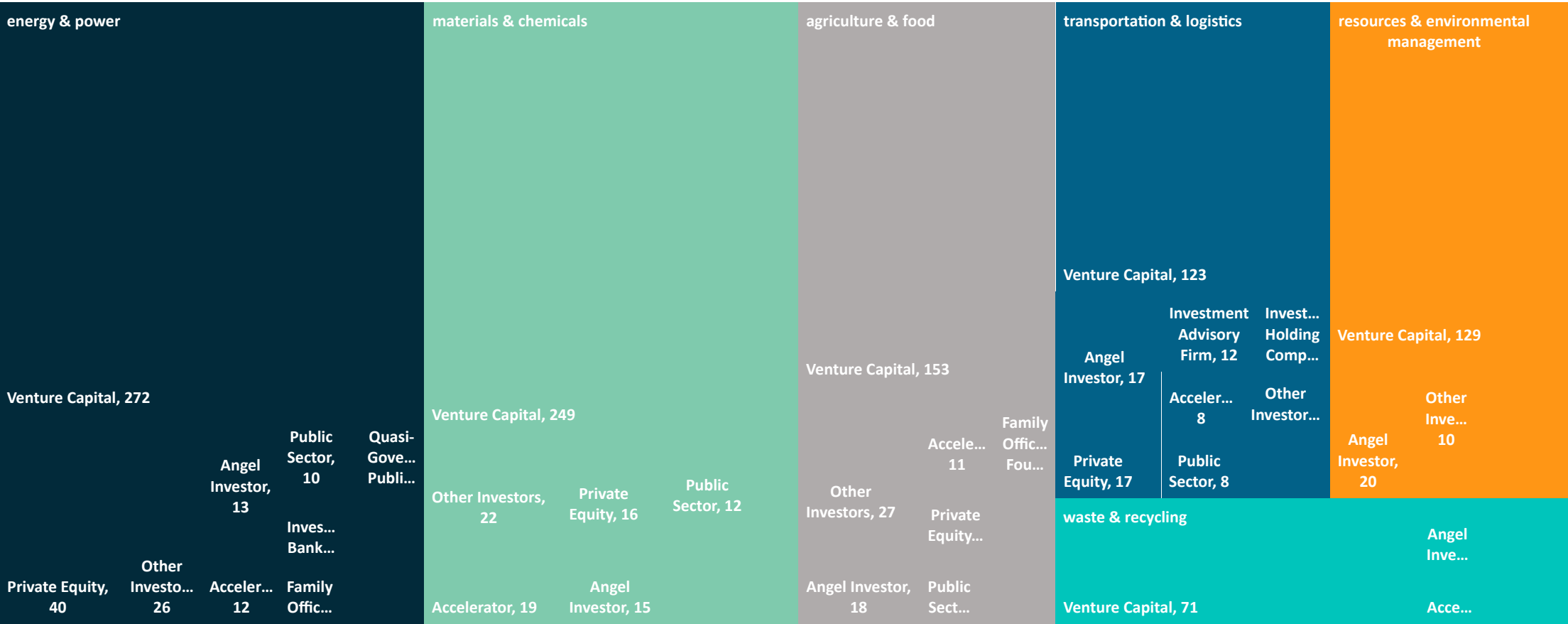
Cleantech Deals by Stage: 4Q24

Average early-stage funding size remained consistent in Q4 while a slight drop in average Seed funding amount and volume carried over from Q3. Late-stage deal volume took a noticeable dive, while funding grew in average deal size through an uptick in large (over \$100M) venture rounds (including outliers), with investors maximizing contributions into fewer rounds. This shift is impacted by increasingly frequent giga rounds and blended funding packages in 2024, as innovators accelerate towards development milestones.



Cleantech Deals by Investor: 4Q24

Investor participation gained a bit of steam in Q4, but overall, 2023 paced ahead with 2024 still 3% short. Corporates participated in 30% of all Q4 deals, a 15% increase from Q3, bolstered by growth rounds raised by innovators concentrated on scaling up and expanding into new markets. While venture capital participation dominates North American activity, their European counterparts share more of the stage with the public sector and entrepreneurial support organizations like startup-incubators/accelerators.



■ agriculture & food ■ energy & power ■ materials & chemicals ■ resources & environmental management ■ transportation & logistics ■ waste & recycling

Special Purpose Acquisition Company Activity: 4Q24 Filed

SPAC Spotlight: Acid battery and lithium-ion recycling technology provider, Ace Green Recycling, has entered into a definitive business combination agreement with Athena Technology Acquisition Corp II, expected to close in 2025. The company has commercial operations in India and Taiwan, with plans to expand operations into the US through this merger and backed by a 15-year agreement with Glencore from 2022 for 100% of its production from its India and Taiwan plants, and the planned US operations.

	Company	Description	Date Announced	SPAC	Valuation
Transportation & Logistics		Smart electric vehicles	05/15/2024	Hudson Acquisition I Corp	\$410M
Waste & Recycling	 ACE Green Recycling	Lead acid and lithium-ion battery recycling technology	12/05/2024	Athena Technology Acquisition Corp II	\$250M

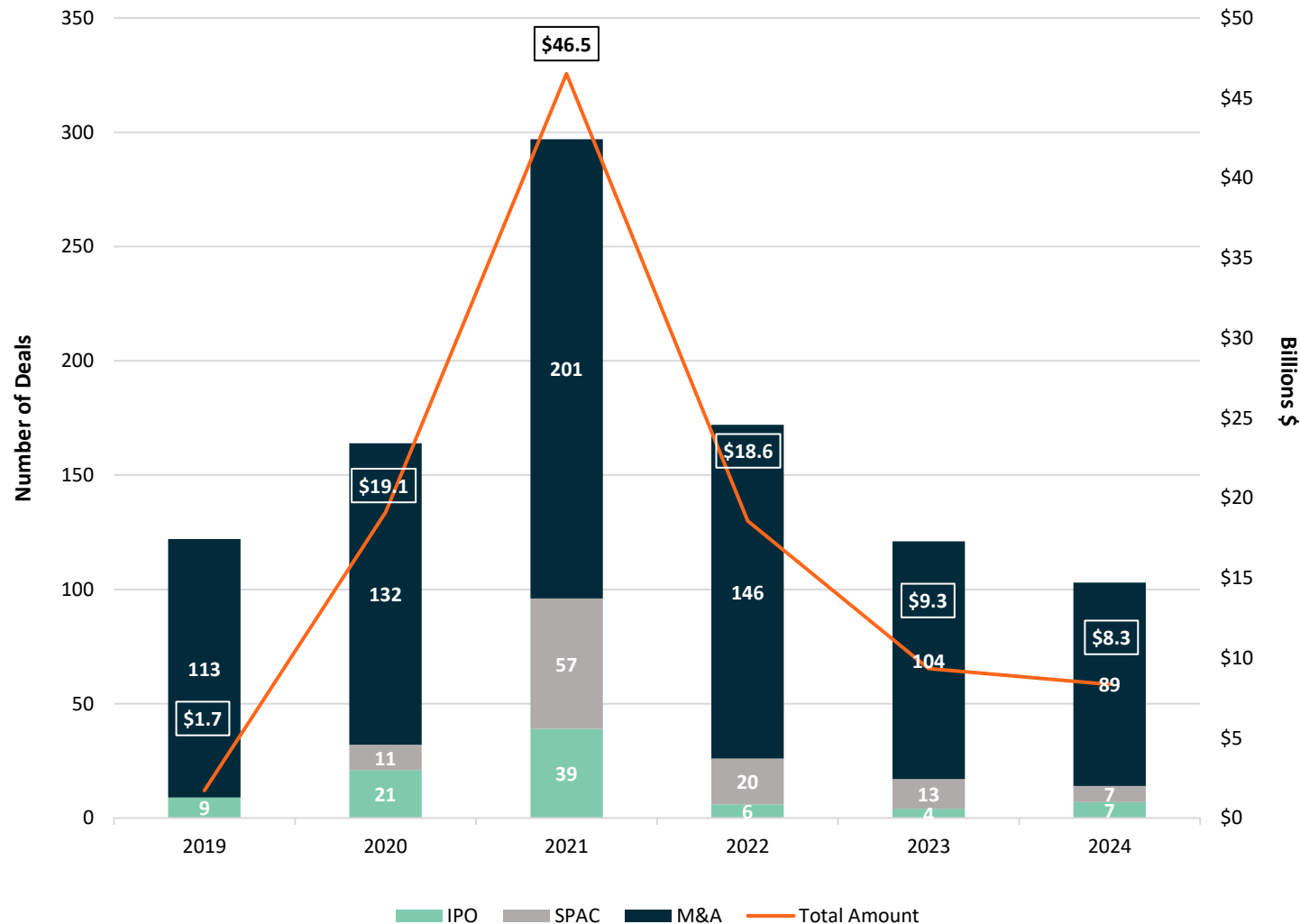
Cleantech Venture-Backed Exits: 4Q24

Q4's activity has brought the year's venture-backed exit activity just short of 2023's figures, with a 10% decrease in total funding closing 2024 at \$8.3B raised over 103 transactions.

The number of venture-backed Mergers & Acquisitions continues to decline year-on-year as deal volume decreased by 50% from Q3 to Q4. The volume of venture-backed SPACs fell by 46% from 2023 as transactions become increasingly more strategic.

IPO activity increased by 75% from last year with two listing in Q4. Majority of 2024's venture-backed IPO activity occurred in the APAC region's Transportation & Logistics innovators developing *electric vehicles*, *electric scooters* and *traffic management* solutions. Innovators in China continued seeking out secure streams of funding amidst a changing market, while Indian e-scooter developers have taken advantage of government incentives and higher fuel prices.




Cleantech Venture-Backed Exits by Deal Volume, 2019 - Q4 2024






*Deal Volume (left) and dollars (right) of global cleantech venture-backed exits

First-of-A-Kind (FOAK): 4Q24 Projects




The US Department of Energy (DOE) focused its first-of-a-kind funding on *energy storage* and battery manufacturing projects this quarter as the public-sector continues to prioritize fostering local technological innovation across the manufacturing supply chain. Lithium-ion battery production is a popular focus for piloting innovation in Q4, with both Lyten and Sparkz commencing development on landmark lithium-ion battery production facilities in the US to address growing local demand.

Company	Project Description	Sector	Total Funding	Funding Type Breakdown (%)	Investors
	The funding was used to launch its first-of-a-kind scalable trading platform that accelerates the clean energy transition CleanTrade. It provides buyers, sellers and traders with price transparency and facilitates end-to-end transaction workflows for contracted clean energy and VPPAs.	Energy & Power, <i>wind</i>	\$32M	100% Equity (Series C)	Equity: Citi, Angeleno Group, undisclosed existing investors
	The grant funding (through cooperative agreement) and supply contract advance the commercial-scale deployment of its Energy Dome's CO2 battery in the US through the Columbia Energy Storage project. The project will feature the battery and aims to set a benchmark for other utilities providers and assist Alliant Energy in incorporating the battery into the existing energy infrastructure.	Energy & Power, <i>energy storage</i>	\$30M	Grant Funding, Signed Supply Contract (Breakdown undisclosed)	Grant Funding: US Department of Energy (DOE) Office of Clean Energy Demonstration Signed Supply Contract: Alliant Energy for the Columbia Energy Storage Project
	The grant funding supports Lewis Ridge Pumped Storage project, subsidiary of Rye Development Acquisition. Once completed, it will be the first pumped storage hydropower facility constructed in the US in more than 30 years and the first sited on former coal mine land.	Energy & Power, <i>energy storage</i>	\$12M	100% Grant funding	Grant Funding: US Department of Energy (DOE) Office of Clean Energy Demonstration

First-of-A-Kind (FOAK): 4Q24 Projects

Company	Project Description	Sector	Total Funding	Funding Type Breakdown (%)	Investors
 Kruger	The partnership, supported by grant funding from the governments of Canada and Québec, have committed investment towards an innovative demonstration project for carbon capture and reuse at its Wayagamack Mill in Trois-Rivières. The technology will be tested for the first time in an industrial setting and will use molten borate salt to directly integrate the capture system into a steam boiler. The two-year test phase is expected to begin in the fall of 2025.	Materials & Chemicals, <i>carbon capture usage & storage (ccus)</i>	\$23.75M	75% Grant Funding, 25% Partnership (Technology Development)	Grant: National Resources Canada (through the Investments in Forest Industry Transformation Program), Ministry of Environment (through the Tecnoclimat Program) Partnership: Mantel Capture Inc
 nel	The partnership inaugurated the world's first dynamic green ammonia plant in Ramme, Denmark. Nel Hydrogen supplied the electrolyzers for the plant, which will produce hydrogen from renewable energy and be synthesized into green ammonia. The plant can adapt to inherent fluctuations of renewable resources, allowing for green ammonia production without the need for battery energy storage.	Energy & Power, <i>hydrogen</i>	NA	Partnership (Project Development)	Partnership: Topsoe, Skovgaard Energy, Vestas
 Commonwealth Fusion Systems	The partnership, led by Commonwealth, will build the world's first commercial fusion plant in Chesterfield. Dominion will provide technical expertise and non-financial development support. The facility is expected to begin operation in the early 2030s with a capacity of 400 megawatts.	Energy & Power, <i>nuclear fusion</i>	NA	Partnership (Development Partner)	Partnership: Dominion Energy

First-of-A-Kind (FOAK): 4Q24 Projects







Company	Project Description	Sector	Total Funding	Funding Type Breakdown (%)	Investors
	The agreement and Series B funding, once closed, will support the development of the world's first maritime civil nuclear program. It will work with Mitsubishi Research Institute to study market conditions for the program in Japan. The program is developing a floating nuclear plant with molten chloride fast reactors and unveiling a concept for a molten-salt reactor powered ship.	Transportation & Logistics, <i>maritime</i>	\$500M*	100% Equity (Series B, raising*), Technology Development Partnership	Partnership: Mitsubishi Research
	The agreement will build the world's first lithium-sulfur gigafactory in Reno, Nevada. Dermody will support in locating and finalizing contractual terms to break ground by 2025. The factory will produce cathode active materials, lithium metal anodes and assemble/produce up to 10GWh of lithium-sulfur batteries annually at full capacity.	Materials & Chemicals, <i>advanced energy materials</i>	NA	Partnership (Memorandum of Understanding)	Partnership: Dermody Properties
	The grant will fund a FOAK production facility for critical raw materials for lithium-ion battery manufacturing. The project will partner with the Mineworkers union to provide former coal miners with job opportunities and facilitate the transition away from fossil fuels in the region. The construction of the factory is ultimately aimed at building a resilient domestic supply chain for LFP batteries.	Materials & Chemicals, <i>advanced energy materials</i>	\$9.8M	100% Grant	Grant: US Department of Energy (DOE)

First-of-A-Kind (FOAK): 4Q24 Projects













Company	Project Description	Sector	Total Funding	Funding Type Breakdown (%)	Investors
divert.	The partnership / first-of-a-kind interconnection aims to address the wasted food crisis in California through renewable natural gas (RNG) production derived from processed food waste. This RNG is injected into PG&E's natural gas transmission line. Divert's facility in Turlock now processes unsold food products into renewable energy through its proprietary anaerobic digestion solution and providing data analytics and insights to curb food waste.	Energy & Power, <i>biomass & waste-to-energy</i>	NA	Partnership (Project Development)	Partnership: PG&E
CARBONCO	The partnership will support development of Canada's proposed first –low carbon urea nitrogen fertilizer facility in Saskatchewan, Canada. The partnership will supply Genesis Fertilizer's farming partners with clean fertilizer. The facility will use CarbonCo's carbon capture technology to capture 800,000 tons of CO2 annually and is slated to begin commercial operations by 2029.	Materials & Chemicals <i>carbon capture usage & storage</i>	NA	Partnership (Licensee Agreement)	Partnership: Genesis Fertilizers

Largest Global Deals – Seed & Series A







Company	Country	Description	Round Size	Investors
	United States	Fusion systems using pulsed magnetic fusion technology	\$ 900,000,000	Breakthrough Energy Ventures, Elad Gil, Eric Schmidt, John Doerr, Ken Griffin, Lachy Groom, Leitmotif, Lowercarbon Capital, Mustafa Suleyman, Patrick Collison, Reid Hoffman, General Catalyst Partners, Andrew Forrest, Lightspeed Venture Partners, Trousdale Ventures, Richard Merki
 Terradot	United States	Carbon removal platform via enhanced rock weathering	\$ 54,000,000	LEAD, John Doerr, Sheryl Sandberg & Tom Bernthal, George Roberts, Strategics, Microsoft Climate Innovation Fund, Google, Cisco, Floodgate Fund, Kleiner Perkins, Acre Venture Partners, Gigascale Capital, Valor Capital Group, Ponderosa Ventures
	United States	Small modular reactors using shipyard manufacturing tools	\$ 45,000,000	Engine Ventures, At One Ventures, Angular Ventures, Tamarack Global, Propeller, Starlight Ventures, Nucleation Capital
	United States	High-performance computing systems to reduce power consumption and heat production	\$ 44,000,000	Nvidia, Kyra Ventures, LifeX, Fathom Fund, Altair, Cisco Investments, OUP, IAG Capital Partners
	Belgium	Battery-as-a-system and energy storage solutions leveraging AI technologies	\$ 42,000,000	RGreen Invest, Wallonie Entrepreneurs, Dovesco Fund Investments
	United States	Polymer intermediates derived from tire rubber waste	\$ 40,000,000	Columbia Pacific Management, Jim Sinegal, Robert Spike Anderson
	United States	Specialty chemicals including intermediates and advanced intermediates for agrochemicals, essential starting materials for dyestuffs, and intermediates for personal care ingredients, among others	\$ 40,000,000	Lightspeed Venture Partners, Alpha Wave Global, HSBC Innovation Banking
	United Kingdom	Nature restoration projects for land and seascapes to recover biodiversity	\$ 37,000,000	Aviva Insurance
 Cleantech Group	Spain	Technology that transforms mealworms into sustainable protein, biofertilizer and chitosan. Carbon negative, zero residue	\$ 32,610,000	Santander, Sodical Instituto Financiero de Castilla y León, GCP Infraestructure, CDTI Invierte Economía Sostenible

Largest Global Deals – Series B & Growth Equity



Company	Country	Description	Round Size	Investors
	China	Smart electric vehicles	\$ 1,520,000,000	Changan Automobile, Huawei, CATL
	United States	Carbon-negative and low carbon cloud computing platform powered by stranded energy such as flare gas and curtailed renewables	\$ 600,000,000	Founders Fund, Long Journey Ventures, Fidelity Ventures, Mubadala, Nvidia, Ribbit Capital, Valor Equity Partners
	Brazil	Data centers and related digital infrastructure	\$ 550,000,000	Coatue
	United States	Nuclear and gas-cooled fast small module reactors	\$ 500,000,000	Amazon, Ares Management, University of Michigan, NGP Energy
	United States	Controllable load solutions for data centres	\$ 500,000,000	Blackstone Group
	United States	Digital mineral exploration software to discover new ethical sources of cobalt	\$ 491,000,000	Funding disclosed via regulatory filing
	United States	Iron-air battery capable of delivering long-duration energy storage for 100 hours to replace existing baseload generation	\$ 405,000,000	T. Rowe Price, GE Vernova, TPG Rise Climate, Breakthrough Energy Ventures, Capricorn Investment Group, Coatue, Energy Impact Partners, Engine Ventures, NGP Capital, Temasek Holdings, GIC, Prelude Ventures, Gigascale Capital, Blindspot Ventures, VamosVentures, Claure Group
	United States	Artificially intelligent hardware to create faster and more efficient processors	\$ 400,000,000	Fidelity Management & Research Company, Google Ventures
	United States	Electric aircraft, eVTOL, and infrastructure for commercial, cargo and passenger applications	\$ 318,437,454	Fidelity Management & Research Company, TPG Rise Climate, Qatar Investment Authority, United Therapeutics
	United States	Small and medium sized launch vehicles for commercial space flight	\$ 175,000,000	RPM Ventures, AE Industrial Partners, GiantLeap Capital

Select 4Q24 Global Fund News

Manager	Location	Fund Amount	Focus & Geography
	Sweden	Verdane Idun II – Venture Capital, \$773.2M (Final Close)	Supports European tech-enabled companies that align with Verdane’s dual investment focus on digitalization and sustainability. The article 9 fund focuses on the energy transition and resource efficiency, targeting investments between €20M and €100M that achieve a minimum carbon avoidance of 5,000 tonnes of CO2 per €1M.
	United Kingdom	Extantia Capital Article 9 Flagship Fund – Venture Capital, \$215.2M (Final Close)	Invests in startups providing software and hardware solutions that address high-impact, near-term opportunities in the climate sector. The fund targets investments through seed to series A rounds ranging from €1-5M.
	India	Green Frontier Capital India Climate Opportunities Fund – Venture Capital, \$177M (Launched)	Aims to encourage Indian investors to support local transformative climate technologies and contribute to national sustainable development goals. Investments will target early-stage (primarily Seed to Series A stage) climate-tech startups in India. The fund will focus on decarbonization, digitization and disruptive technologies.
	France	360 LIFE II – Venture Capital, \$145.7M (Interim Close)	Continues 360 Capital’s strategy dedicated to advancing innovations in circular economy and the energy transition. Investments will target pan-European Series A and Series B startups. The fund will focus on sectors such as renewable energy, energy storage, hydrogen, waste reduction, blue economy, natural resource protection, pollution reduction, net-zero solutions, and smart infrastructure.
	France	Axeleo Capital Climate Tech Fund – Venture Capital, \$134.2M (Interim Close)	Aims to finance innovative, resilient green technologies in Europe. It will target make 15 to 20 investments ranging from €3M to €10M. Sector focuses include energy (new renewable energies, storage), chemicals and materials (biomaterials, plastics recycling), agriculture and food (bio-based fertilizers and pesticides) and mobility (electric motors, decarbonized of air and sea transport).
	France	Capagro Fund II – Venture Capital, \$121.5M (Interim Close)	Supporting the growth of the most promising startups in the European AgTech and food technology sectors. The fund will target investment in around fifteen companies, rolling out investments that range between €3M to €10M.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

Energy & Power

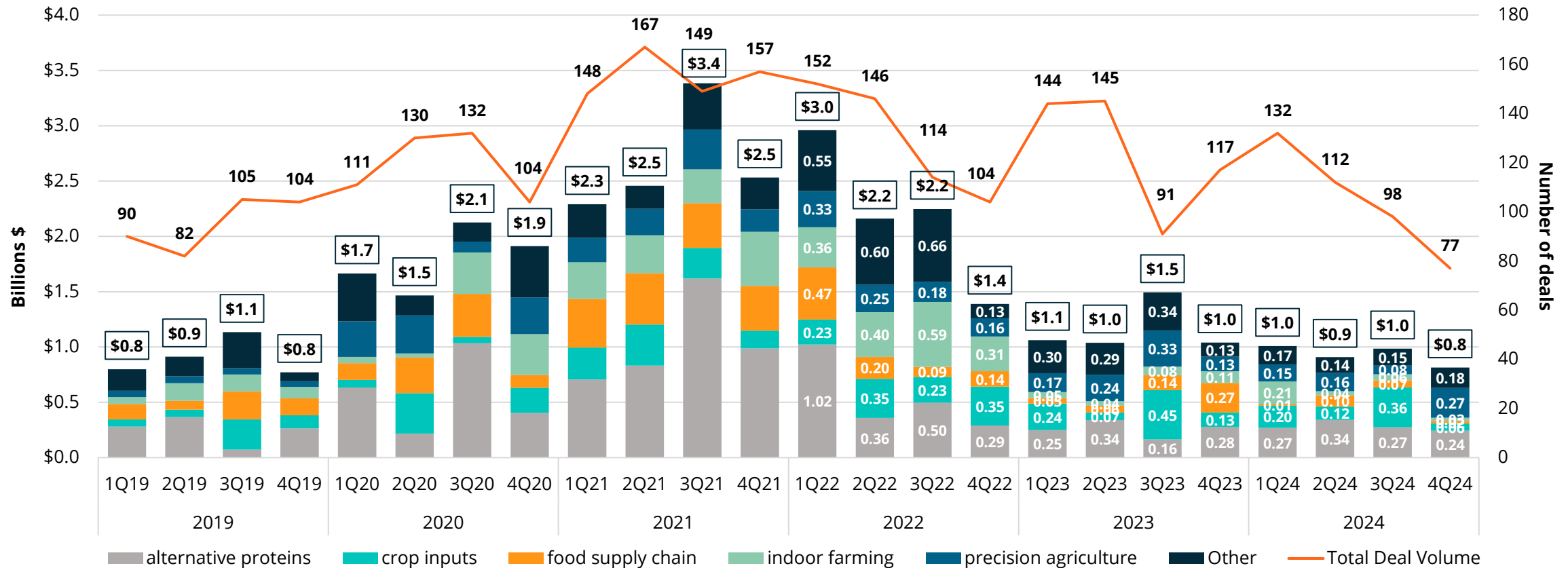
Materials & Chemicals

Resources & Environmental Management

Transport & Logistics

Waste & Recycling

Agriculture & Food: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- Total Agriculture & Food funding dipped further in Q4 as purse-strings continued to tighten amid economic uncertainty and a correction from post-Covid stimulus for technologies including *crop inputs* and *indoor farming*.
- *Precision agriculture* was the industry group's highest-funded subsector, banking \$269M (33% of the total) across 19 deals, as increasingly cautious investors bank on innovators tackling fundamental farm-level problems like operational efficiency and labor availability.
- While late-stage deal volume remained flat throughout 2024, early-stage deal numbers halved from 108 transactions in Q1 to 54 in Q4. This was driven by a drop in *alternative protein* investments, as the segment came to terms with several company failures and limited progress on sales growth.

Agriculture & Food: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- **BASF** has partnered with AgroSpheres to develop and commercialize its bioinsecticide products based on the start-up's agricell technology
- Thailand-based meat products company **Betagro** invested in alt-protein innovator Meatable to accelerate its market entry in Asia
- **Chevron** made a strategic investment in crop and agroforestry innovator Terviva to advance pongamia tree oil as a biofuel feedstock

Investors:

- **EIT Food** partnered with **European Bank for Reconstruction and Development (EBRD)** for the 'Future Resilient Agriculture' accelerator targeting early-stage startups across sectors including, soil health and biodiversity, water management, crop innovation, carbon and nitrogen farming, MRVs, and smart farming robotics
- **Ahimsa Companies** acquired alternative meat proteins start-up Simulate
- **Pymwymic** raised \$76.5M for its Impact Fund II targeting solutions across global food supply chains, crop intelligence, food waste, and soil health

Entrepreneurial Support Organizations:

- **The Cultured Hub**, a biotech facility and joint venture by corporates Bühler, Givaudan, and Migros opened in Q4 to scale cellular agriculture innovation

Public Sector:

- The UK's **Food Standards Agency** and **Food Standards Scotland** announced a cultivated meat regulatory sandbox with \$2.1M government funding
- The **European Court of Justice** ruled that France's 2021 decree banning the use of meat-related terms to describe plant-based products is unlawful

Innovators

Precision Agriculture: automation and robotics solutions scored big checks amid a drive to crack on-farm efficiency and labor challenges

- **Carbon Robotics** secured \$70M in funding from Bond, Fuse, Nvidia's NVentures, and others to introduce new products beyond its automated laser-powered weeding robot, and expand its manufacturing capabilities
- A tractor automation startup, **Agtonomy**, closed its Series B round at \$32.8M with investment from AutoTech Ventures, Toyota Ventures, Cavallo Ventures and others to expand its pilot program and enter new markets

Alternative Proteins: innovators working on plant-based proteins roped in a slight resurgence in interest from investors

- Plant-based meat alternatives startup **La Vie**, secured \$27.5M Series B funding from Zintinus Capital, Sparkfood, and others for product development
- **Plantible Foods**, developer of duckweed-derived protein, raised \$30M Series B funding from Piva Capital, Siddhi Capital, ICL, and others to scale up production

Animals: platforms driving efficiency in livestock agriculture secured 10% of total Q4 funding, with Asian innovators leading the way

- **Stellapps**, developing a dairy farm optimization software, banked \$26M equity funding from Blume Ventures, Gates Foundation, 500 Global, and others
- A poultry farm management startup, **Chickin**, raised \$20M Series A funding from investors incl Granite Asia, East Ventures, and ADB

Crop Inputs: crop protection, nutrition, and improvement technologies continued to attract funds from climate adaptation-minded investors:

- **Sound Agriculture** scored a \$25M Growth Equity extension from BMO and S2G Ventures for its nutrient-boosting biostimulant product
- **BioPrime AgriSolutions** raised \$6M Series A funding from Edaphon, Omnivore, and Inflexor Ventures to advance its biopesticide R&D

Agriculture & Food Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Agriculture & Food industry



Recent Published Research

- **Spotlight:** AI for Crop Input Discovery & Development (Q1 2025)
- **Spotlight:** Non-food Crops for Biofuels (Q1 2025)
- **Spotlight:** Traceability & Provenance (Q4 2024)
- **Spotlight:** Insect Farming (Q4 2024)
- **Sector Insight:** Agri-food Waste Mitigation (Q3 2024)
- **Sector Insight:** Crop Inputs (Q2 2024)
- **Spotlight:** Synthetic Fertilizers (Q1 2024)
- **Spotlight:** Biochar (Q4 2023)

Upcoming Topics

- **Spotlight:** Methane Inhibition in Livestock (Q2 2025)
- **Spotlight:** Biostimulants (Q2 2025)

Upcoming Events

- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Lead Analyst – Jack Ellis

- Senior Associate leading Agriculture & Food research at Cleantech Group.
- Jack's professional background is in communications, industry research, and venture capital.
- Prior to joining Cleantech Group, he was Research Lead at agrifoodtech investor AgFunder and Deputy Editor of industry news site *AFN*.
- Jack earned a bachelor's degree in Philosophy from the University of Sheffield.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

 **Energy & Power**

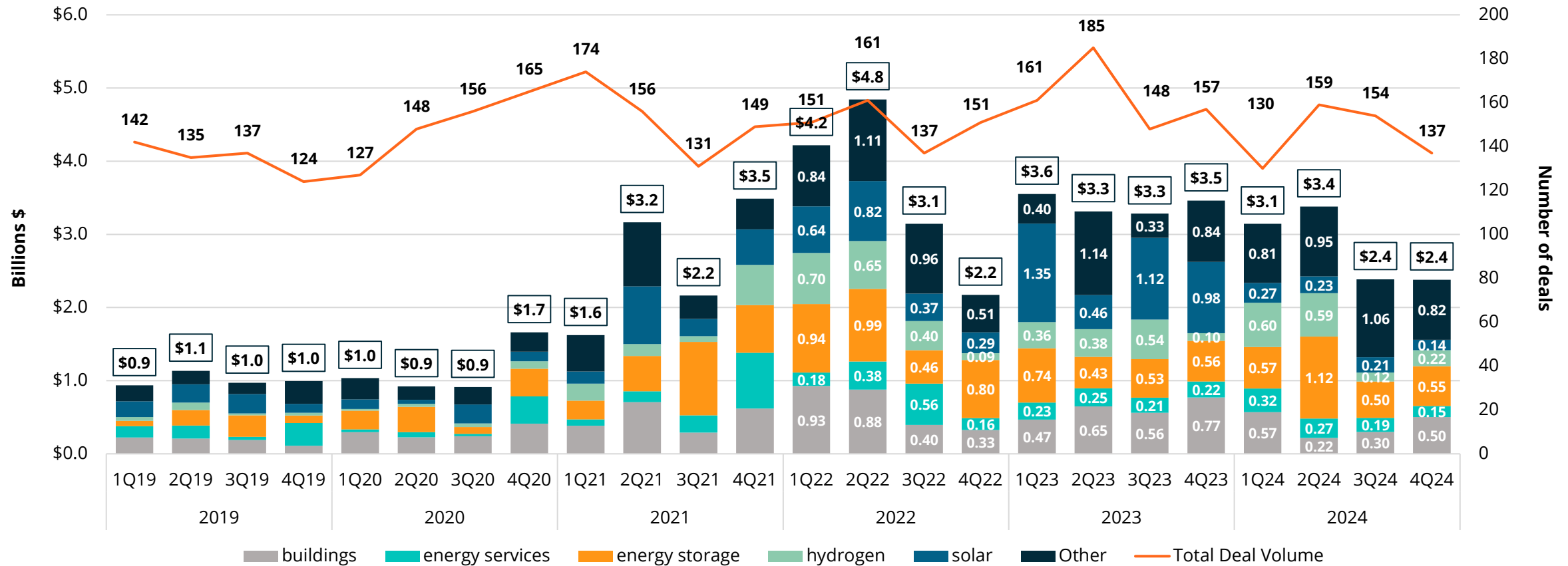
Materials & Chemicals

Resources & Environmental Management

Transport & Logistics

Waste & Recycling

Energy & Power: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- Total funding for Energy & Power in Q4 stalled at \$2.4B when excluding deals over \$350M; including outliers pushes the total to its highest since Q1 2022 at \$6.2B, driven by large nuclear fusion deals, including Pacific Fusion's \$900M Series A to advance replicable reactors for energy generation.
- Despite uncertainty around US elections, North America held the highest share of venture dollars in 2024 driven by investments into nuclear fusion and energy storage, accounting for 45% share of Energy & Power's 2024 investments (\$11.3B), followed by the EU (43.3% - \$4.9B) and Asia Pacific (11% - \$1.2B).
- Mergers & Acquisitions dropped to 10 in Q4, closing 2024 with 43, the lowest in terms of volume in the last 20 years due to high-interest rate environment.

Energy & Power: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- **Amazon** committed \$500M to small modular reactor (SMR) developer X-Energy's equity round and agreed to develop 5GW of power by 2039
- **Mitsubishi Heavy Industries (MHI)** and **Osaka Gas** invested \$50M into natural hydrogen startup Koloma's Series B extension round

Investors:

- **Move Energy** landed \$36M commitment by European Investment Fund (EIF) for its Fund I decarbonising the energy sector
- **Lowercarbon Capital** expanded its portfolio by five companies in Q4 2024, including fusion companies Acceleron Fusion and Pacific Fusion
- **Intudo** raised \$125M for its Fund IV targeting downstream renewable energy and natural resources investments in Indonesia

Entrepreneurial Support Organizations:

- **Elemental Impact Accelerator** invested \$18.6M across cohort of 16 startups, including hydrogen producer Found Energy and battery developer Noon Energy
- **Net Zero Technology Centre** awarded \$0.62M to three hydrogen companies and contributed \$0.75M to the H2Chp heat and power technology grant

Public Sector:

- The **US Department of Energy (DOE)** chose 38 projects to receive \$2B from its grid resiliency and infrastructure (GRIP) funding
- Newly proposed national energy and investment company **Great British Energy** will receive £100 million for clean energy projects in 2025-26
- **Port of Pecém** in Brazil, has signed \$1.5B agreement with Fuella to develop a project producing 400,000 tons of green ammonia annually

Innovators

Energy Storage: venture investors targeted later-stage lower risk energy storage technologies with proven potential, with less than 20% of storage investments were into early-stage technologies this quarter

- Iron-air long duration storage (LDES) developer **Form Energy** raised \$405M of growth equity from backers including Breakthrough Energy Ventures and Energy Impact Partners
- Lithium nickel manganese cobalt (NMC) battery developer **InoBat** raised a \$104M growth equity round from investors including Rio Tinto and Gotion

Data Centers: technology providers are feeling the energy crunch and are investing in solutions to support sustainable data center growth to meet increasing demands for AI and high-performance computing

- Data center operators raised substantial funds this quarter, including **Crusoe Energy Systems** raising \$600M for low carbon computing and data center startup, **Lancium** reporting a \$500M Series B round
- Cooling technologies including direct-to-chip and immersion cooling that will reduce energy and power demands for IT systems raised venture investments this quarter including, **Accelsius'** \$24M round and **Submer** securing \$55M

Nuclear: novel reactor companies pulled in fresh capital as investors continue to diversify investment opportunities for renewable generation to meet growing energy demands

- **X-Energy** raised \$500M with support from Amazon and other investors
- Microreactor developer, **Radiant**, raised \$100M and **Antares** raised \$30M
- **Blue Energy** raised \$45M and will manufacture components in shipyards to reduce costs and time related to building pressurized light water reactors
- **Pacific Fusion** emerged from stealth with \$900M tied to milestone-based targets to support their pulsed magnetic inertial fusion reactor system
- Fusion startup **Tokamak Energy** raised \$125M and **Acceleron** raised \$24M

Energy & Power Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Energy & Power industry



Recent Published Research

- **Sector Spotlight:** Industrial Heat Pumps (Q4 2024)
- **Sector Insight:** Decarbonising <250c Industrial Heat (Q 2024)
- **Spotlight:** Geothermal drilling (Q2 2024)
- **Insight:** Decarbonized Home (Q1 2024)

Upcoming Topics

- **Sector Spotlight:** Industrial Optimization (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Lead Analyst – Selene Law

- Senior Associate leading Energy & Power research at Cleantech Group, based in the UK.
- Selene has over ten years of experience working in the energy sector in an analytical and journalistic capacity, covering the entire value chain from upstream oil to power and renewables. Prior to Cleantech Group, Selene worked in S&P Global, Wood Mackenzie, and Fitch Research.
- She has a degree in journalism from Falmouth University in Cornwall, UK and a postgraduate degree in international relations from the University of Bristol.

Energy & Power Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Energy & Power industry



Recent Published Research

- **Insight:** Data Centre Decarbonisation (Q3 2024)
- **Spotlight:** Grid Resilience (Q2 2024)
- **Insight:** Decarbonized Home (Q1 2024)
- **Spotlight:** Small Modular Reactors (Q4 2023)
- **Sector Insight:** Marine Energy (Q3 2023)

Upcoming Topics

- **Sector Insight:** Modular Nuclear Reactors (Q1 2025)

Upcoming Events

- **Cleantech Forum Europe** – Chantilly France – November 5-6, 2024
- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Zainab Gilani

- Focused on emerging innovation and trends across the Energy & Power industry group.
- She has experience working on nuclear fusion, circular economy solutions including evaluating recycling challenges and reuse systems, identifying collection strategies for marine plastics, and collaborating with informal waste worker collectives.
- Zainab earned her Undergraduate Degrees in Physics and English from Binghamton University.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

Energy & Power

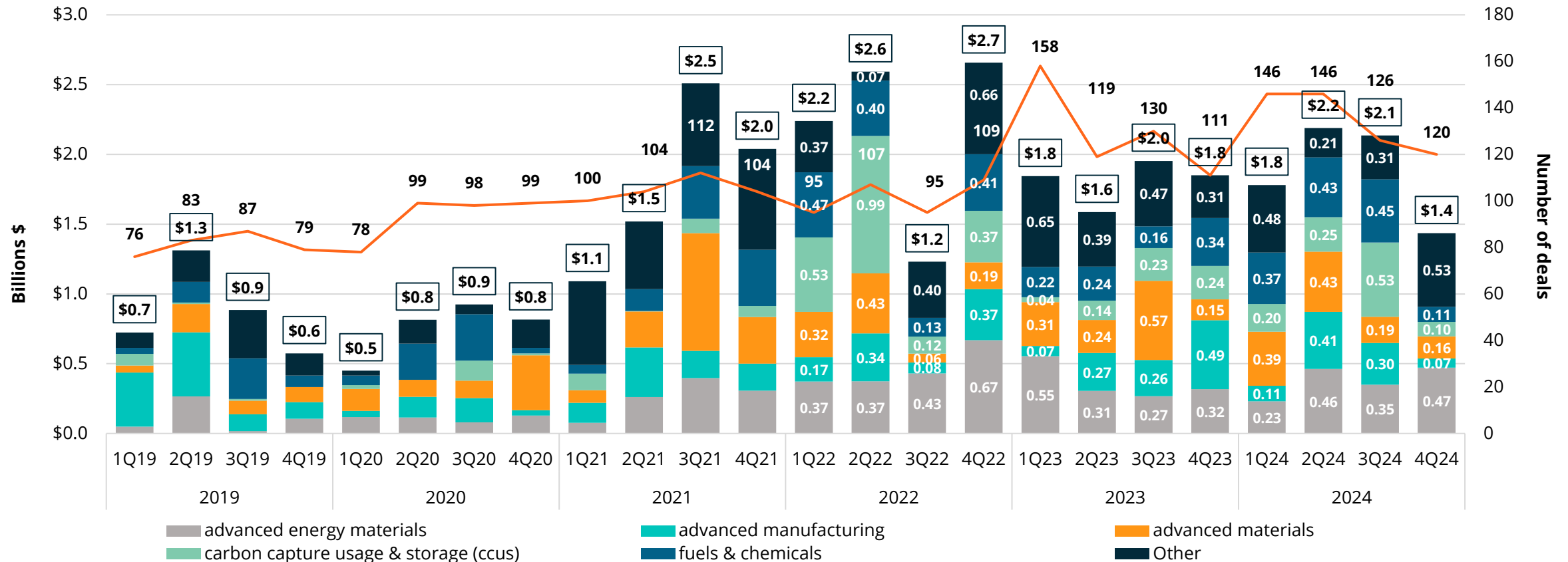
 **Materials & Chemicals**

Resources & Environmental Management

Transport & Logistics

Waste & Recycling

Materials & Chemicals: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- Funding in Q4 dropped by 33% compared to Q3 –the lowest it’s been since 3Q22– as innovators raised smaller venture rounds. While funding for *carbon capture usage & storage* dipped in Q4, it shot up at Y-o-Y view, reaching \$1.08B in 2024 as investors put big dollars into getting projects to market.
- Advanced energy materials* and *industrial materials* attracted the bulk of funding, including Ayar Labs’ \$155M round for miniaturized fiber optic cables and Fleet Space Technologies’ \$100M round towards its satellite-based exploration platform for critical minerals.
- From the \$7.5B raised for Materials & Chemicals innovation in 2024, North America secured the highest amount at \$3.6B (48%), largely for *advanced energy materials* and *carbon capture, utilization & storage* solutions, as investors continue mirroring large infrastructure investments by the public sector.

Materials & Chemicals: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- **Barclays**, through its Sustainable Impact Fund, participated in Luxwall's \$51M Series B for its glass-based transparent insulation for buildings.
- **Samsung** partnered with Liquid Wind to develop eFuels facilities beyond Europe, Asia, Africa, and the Middle East as part of its \$46M growth equity

Investors:

- **BPIFrance** invested in biobased solutions including LACTIPS for bioplastics and Biomemory for DNA-based data storage. Faircraft's cultivated leather and Aerleum's clean fuels from captured CO₂ also attracted funds
- **TechStars** invested in Envicore's cement substitute from industrial waste, Movopack's reusable packaging solutions, and Ecoelectro's AEM electrolyzers

Entrepreneurial Support Organizations:

- **SRTX Origins** launched a material science incubator to provide startups with scaling support and manufacturing resources. MycoFutures, a mycelium-based leather alternative, is the first innovator in its portfolio
- **Innovate UK** invested in 5 innovators: Deep Blue Biotech synthetic biology platform for biofuels and bioplastics; Paragraf's graphene technology; HUID's onion skin packaging; Cocoon and Low Carbon Materials' cement & concrete

Public Sector:

- The **US Environmental Protection Agency (EPA)** finalized a ruling to reduce methane emissions in O&G, a move likely to support carbon capture and turquoise hydrogen; and another rule to reduce harmful Nitrogen Oxide (NOx) emissions will result in new gas turbines with low or emission-free pathways (e.g. using catalyst instead of combustion)

Innovators

Electronics: semiconductors power electronics, meanwhile, control chips process information that is communicated across networks by fiber optic cables, among other components

- **Ayar Labs** received the largest funding this quarter with a \$155M in equity to commercialize miniaturized, low-energy fiber optic silicon chips. The investors include 3M Ventures, Lockheed Martin Ventures and 13 more
- **Jingneng Microelectronics** raised \$70.3M Series B from Xiuzhou Linghang Fund for its high-power semiconductor products for electronics, aerospace and renewables
- **Geijan Semiconductor** raised \$20.7M Series A for its real-time control digital smart processor chips for electronics. Funding from Weihe Investment and Shanghai Chaos Investment

Critical Minerals: key components of cleantech including for batteries, electrolyzers, solar panels and wind turbines, among others

- **Fleet Space Technologies** raised \$100M in Growth Equity for its satellite-based exploration platform for critical minerals. Funding by Hostplus, Horizon Ventures and 4 others
- **EnergyX** raised \$75M to execute commercial direct lithium extraction projects in Chile and the US. It also launched a new headquarters in Austin, TX

Biotechnology: using living organisms (microbes, plants or animal biomass) to develop components or products like foods, ingredients, fuels, chemicals, etc.

- **Cradle Bio** raised \$73M Series B from IVP, Index Ventures and Kindred Capital to develop complex proteins from its AI-powered protein platform
- **Element Drive's** biomanufacturing platform utilizing soybeans raised \$28M in Series A funding from Hangzhou Urban Investment Industry Fund and 3 others
- **Industrial Microbes** raised \$10M Seed to produce sustainable chemicals from methane using microbes from First Bridge Ventures and Universal Materials Incubator

Materials & Chemicals Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Materials & Chemicals industry



Recent Published Research

- **Spotlight:** Electrifying Chemicals (Q3 2024)
- **Sector Insight:** Sustainable Aviation Fuel (SAF) (Q4 2023)
- **Spotlight:** Cathode manufacturing (Q3 2023)
- **Spotlight:** Ammonia processing (Q3 2023)
- **Spotlight:** Sustainable Aviation Fuels: eJet (Q2 2023)
- **Spotlight:** Silicon anodes (Q1 2023)
- **Spotlight:** Decarbonizing cement & concrete (Q4 2022)

Upcoming Topics

- **Sector Insight:** Green Ammonia (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Group Lead – Ian Hayton

- Materials & Chemical analyst, engineering and business professional with a passion for technology, innovation and the environment. Experienced in strategy, marketing, business support and R&D.
- Prior to joining Cleantech, Ian held several roles at a Sustainable Innovation Consultancy, including chemical process engineer, and chemical research engineer.
- Ian earned an MSc degree in Chemical Engineering from the University of Manchester.

Materials & Chemicals Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Materials & Chemicals industry



Recent Published Research

- **Insight** Point Source Carbon Capture (Q3 2024)
- **Spotlight** Cell-free Biomanufacturing (Q2 2024)
- **Spotlight:** Biobased Plastics and Alternatives (Bioplastics) (Q1 2024)
- **Spotlight:** Biochar (Q4 2023)
- **Sector Insight:** Low-carbon Hydrogen (Q3 2023)
- **Spotlight:** Direct Lithium Extraction (Q2 2024)

Upcoming Topics

- **Sector Insight:** Cement Decarbonization (Q1 2025)
- **Spotlight:** Digital Materials Discovery (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Buff López

- Materials & Chemical analyst, chemicals and business professional with a passion for technology, innovation and the environment. Helping start-ups grow through connections to strategic partners and investors.
- Buff earned a B.S. Chemistry from The University of Texas at Austin.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

Energy & Power

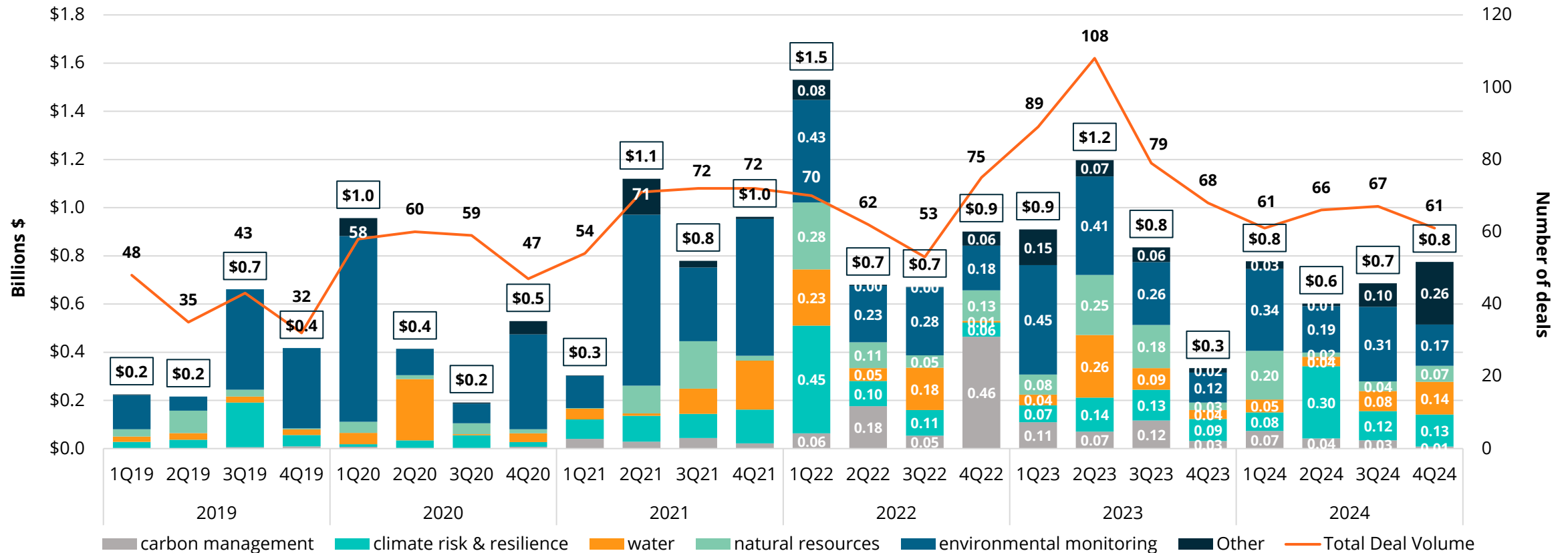
Materials & Chemicals

 **Resources & Environmental Management**

Transport & Logistics

Waste & Recycling

Resources & Environmental Management: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- Resources & Environmental Management raised \$0.8B across 61 deals in Q4 2024, excluding an \$491M outlier deal by Kobold Metals Systems bringing the close to \$1.3B. Total deal volume and funding amount kept relatively consistent each quarter in 2024 as funding levels return from a dip in Q4 2023, reflecting stable investor interest and market maturity for the industry group.
- Investments for *environmental monitoring* fluctuated across 2024, with funding amount dropping by 45% between Q3 and Q4; the decline from \$0.31B to \$0.17B is sharp, with the likelihood of a rebound in the coming year hinged upon adoption of risk assessment and carbon capture technologies.
- Water* has continued an upward trajectory all year, exhibiting increasing investor confidence particularly in burgeoning desalination technologies.

Resources & Environmental Management: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- **Microsoft** and **Google** make their first-ever direct investments in an enhanced rock weathering company by participating in Terradot's \$54M Series A round
- **Google** participated in Pixxel's \$24M Series A round to support the launch of 18 advanced small earth imaging satellites; and in a \$1M Seed round for EcoRatings to propel its AI/ML-based sustainability assessments

Investors:

- **Blackrock** participated in Iceye's \$65M extension round to further develop its SAR satellite constellation, its intelligence, surveillance, and reconnaissance (ISR) platform, and related systems
- **Aviva Investors** launched a Carbon Removals Fund (CRF) to invest in nature-based and engineered solutions, and alternative carbon removal startups

Entrepreneurial Support Organizations:

- **Ocean Startup Project's** 2024 cohort included three water monitoring and analysis innovators (EcoMarine Technologies, Ocean Riot, and Deepwater Robotics), and other innovators for carbon removal and pollution monitoring
- **XPRIZE Rainforest** announced its four winners targeting rainforest monitoring to improve biodiversity conservation efforts in the Amazon: Limelight Rainforest, Map of Life Rapid Assessment, Brazilian Team, and ETH BiodivX

Public Sector:

- Dryad received a public sector grant from the **European Regional Development Fund** and **Investitionsbank des Landes Brandenburg**, as part of public climate resilience strategies including wildfire management
- **Carbon Removal:** US Department of Energy (DOE) provided project finance for **Carbon Lockdown** (\$5.9M), and **Carba** (\$10.1M) as part of project selections for 'FOA 3082: CARBON NEGATIVE SHOT PILOTS'

Innovators

Carbon Removal: energy demand by data centers and the increasing maturity of enhanced weathering technologies drew venture investment rounds with corporates piling in

- **Terradot**, a carbon removal platform through enhanced rock weathering, raised \$54M with investors including Google, CISCO and Microsoft, to scale pilot operations in Brazil
- **Heirloom** for enhanced weathering-based carbon capture processes, raised \$150M from 13 investors including Lowercarbon Capital, Japan Airlines, Mitsubishi, and Breakthrough Energy Ventures
- **Vaulted Deep**, designing a slurry sequestration technology that injects organic waste underground for permanent carbon removal, raised \$32.3M to develop additional injection well sites
- **Planetary Tech**, developing a marine carbon removal platform and process that uses ocean alkalinity enhancement, raised \$11.3M to expand pilot projects, scale product development and facilitate continued efficacy and safety demonstrations for its technology

Water: continued interest from investors focused on expanding geographic scale of market-ready water tech solutions to increase quantity and quality of potable water, and optimize water management

- **Haber Water**, an AI-based platform for water and energy optimization in industrial manufacturing processes, raised \$38M to accelerate their expansion into North America
- **BE WTR**: filtered potable water from local taps, raised \$45.5M from Peakbridge Partners and others, to scale its technology and expand into new markets, with Abu Dhabi being next on the agenda
- **Aquaria**, providing atmospheric water generators (AWGs) to harness water from ambient air and provide potable water, raised \$12M to expand residential, hospitality and commercial projects in new regions

Resources & Environmental Management Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Resources & Environmental Management industry



Recent Published Research

- **Insight:** Innovation in MRV for Transparency in Carbon Offsets (Q4 2024)
- **Insight:** Textile Recycling (Q4 2024)
- **Sector Insight:** Climate Resilient Infrastructure (Q4 2024)
- **Insight:** Battery Recycling (Q2 2024)
- **Insight:** Plastic Recycling (Q1 2024)
- **Spotlight Insight:** Wildfire Risk & Resilience (Q1 2024)
- **Spotlight Insight:** Mining Exploration – Impact Reduction & Avoidance (Q4 2023)
- **Insight:** Marine Carbon Dioxide Removal (Q4 2023)
- **Spotlight Insight:** Biodiversity & Ecosystem Monitoring (Q3 2023)

Upcoming Topics

- **Insight:** Insurance & Cleantech (Q1 2025)
- **Sector Insight:** Geoengineering (Q1 2025)
- **Spotlight:** Earth Observation & Sensing (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** –North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Lead Analyst – Holly Stower

- Focused on emerging innovation & trends across resources and environmental management and waste industry groups, including water, waste, circular economy, natural resources, oceans & corporate sustainability.
- Leading Cleantech Group's blue economy Strategic Intelligent Service, our cross-sectoral research including active engagement with the innovators and key stakeholders that are catalyzing business opportunities, through an annual membership
- Prior to joining Cleantech Group, Holly was a Public Affairs & Communications Executive with the Solar Trade Association & the Association of British Insurers.
- Holly earned Undergraduate & Masters degrees in Environmental Science from the University of East Anglia.

Resources & Environmental Management Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Resources & Environmental Management industry



Recent Published Research

- **Sector Insight:** Water Harvesting & Purification (Q3 2024)
- **Spotlight Insight:** Wildfire Risk & Resilience (Q1 2024)
- **Spotlight Insight:** Mining Exploration – Impact Reduction & Avoidance (Q4 2023)
- **Sector Insight:** Marine Carbon Dioxide Removal (Q4 2023)
- **Spotlight Insight:** Biodiversity & Ecosystem Monitoring (Q3 2023)
- **Sector Insight:** Critical Metals Sustainability (Q2 2023)
- **Sector Insight:** Innovation in Due Diligence for Carbon Offsets (Q4 2024)

Upcoming Topics

- **Sector Insight:** Geoengineering (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** –North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Alex Crutchfield

- Focused on emerging innovation & trends across the resources & environment sectors including carbon capture and climate resilience.
- Alex's professional background is in journalism and policy research. Prior to Cleantech Group, Alex served as a foreign correspondent in Latin America for The Business Year and published his work in various think tanks including the Spanish Royal Institute of European Studies.
- Alex earned a bachelor's degree in Journalism and Global Affairs at the University of North Carolina at Chapel Hill and a master's degree in International Relations from Universidad CEU San Pablo.

Resources & Environmental Management Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Resources & Environmental Management industry



Recent Published Research

- **Sector Insight:** Climate Resilient Infrastructure (Q4 2024)
- **Spotlight:** Food Traceability & Provenance (Q4 2024)
- **Spotlight:** Solid Oxide Electrolyzers (Q3 2024)
- **Spotlight:** Port Decarbonization (Q2 2024)
- **Sector Insight:** Maritime Sustainability (Q1 2024)
- **Sector Insight:** Sustainable Aviation Fuels (Q4 2023)
- **Spotlight:** Smart Waste Collection (Q3 2023)

Upcoming Topics

- **Spotlight:** Earth Observation & Sensing (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** –North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Sunena Gupta

- Focused on emerging innovation & trends across the resources & environment sectors including the sustainable use of resources, carbon removal, climate resilience and environmental monitoring
- Sunena earned an Undergraduate degree from the University of California, Berkeley, and a Masters degree in Public Policy from the University of Chicago.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

Energy & Power

Materials & Chemicals

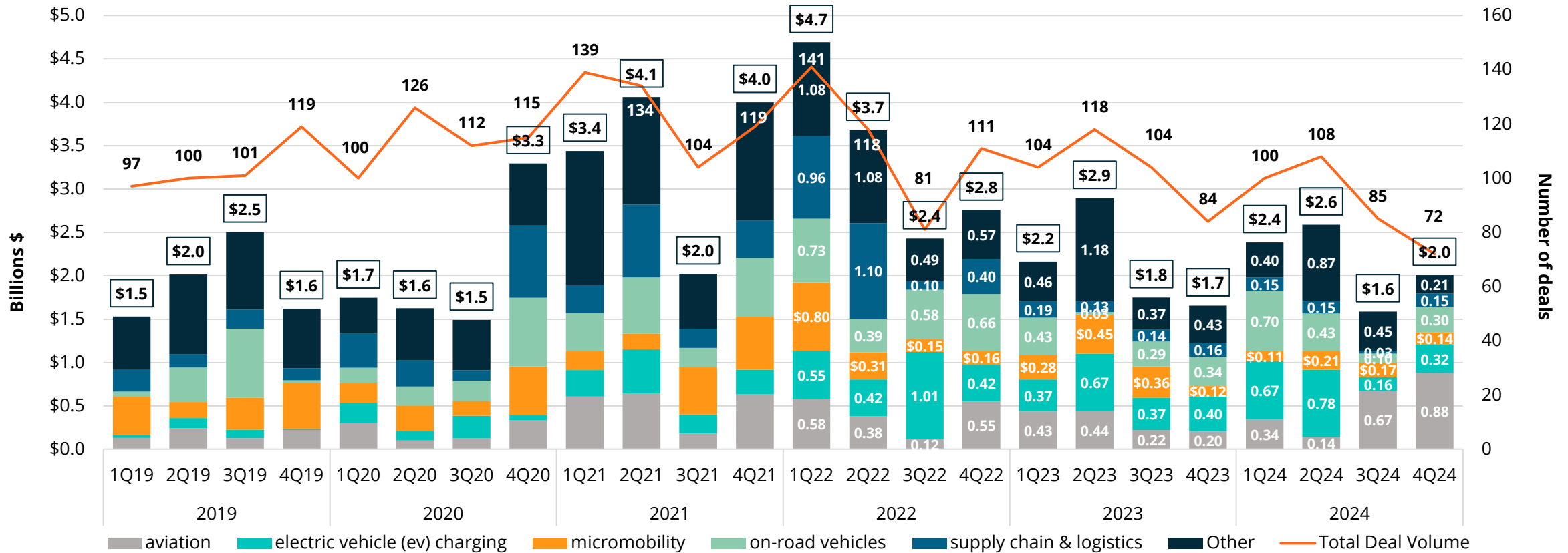
Resources & Environmental Management



Transport & Logistics

Waste & Recycling

Transportation & Logistics: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- While Transportation & Logistics' Q4 investment numbers recovered from last quarter, 2H24 settled with low figures of \$3.6B around the ballpark of the 2H23, with funding in Europe notably dropping from \$2.3B in 1H24 to \$0.7B in 2H24 (excluding outlier deals).
- Overall, the total investment amount for 2024 remained on par with 2023 (\$8.5B and \$8.6B respectively) as the considerable decrease *ev charging* and *on road vehicles* investments raised early in the year was compensated by record-high *aviation* investment in the second half of 2024 (\$1.5B).
- Funding in *aviation* reached an all-time quarterly high of \$0.88B across 17 deals in Q4, receiving 11% of all quarterly cleantech investments and 44% for Transport & Logistics in Q4. The long-awaited regulatory approval for eVTOL commercial flight drove the capital mobilisation for eVTOLs innovators.

Transport & Logistics: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- Automotive OEMs collaborate across the EV and battery value chain, with **Mercedes-Benz** and **BMW** in a joint-venture with IONCHI to deploy fast-charging network across Japan; **Valeo** and **MAHLE Group** partnered on magnet-free electric motors; and **Rivian** and **Volkswagen** joined forces for next-gen electrical architecture and software
- Maritime corporates engaged with propulsion optimization and emissions reduction innovators, including **Maersk's** installation of bound4blue wind propulsion systems on medium-range vessels; **Smart Green Shipping** and Drax partnering to demonstrate FastRig propulsion technology; and **Westinghouse Electric** partnered with Core-Power to develop floating nuclear powerplants to power vessels and ports

Investors:

- **Trucks VC** launched a \$70M fund for green transportation technologies, including electric vehicles, mobility platform, autonomous vehicle solutions and more
- **EQT Ventures** invested in hydrofoil electric boat developer Candela Boats and spacecraft innovator The Exploration Company

Entrepreneurial Support Organizations:

- **Ocean Startup Project's** 2024 cohort included maritime vessel developer Celerity, and REPWR for integrated solar systems for shipping containers and port logistics

Public Sector:

- **Natural Resources Canada** poured \$13.3M into Zero Emission Vehicle Infrastructure to deploy EV chargers across Canada; **US Department of Energy (DOE)** committed a \$6B loan for Rivian's EV manufacturing, and the Loan Programs Office provided \$1B condition loan for Evgo to deploy public EV charging infrastructure across the country
- **European Investment Bank** approved over \$1.5B in aid programs to develop high-powered charging infrastructure for heavy-duty vehicles in Poland

Innovators

Aviation: hardware and software solutions for aircraft fuel and emissions efficiency continued to attracting funding across TRLs

- **Beta Technologies**, developing electric aircrafts, eVTOLs, and charging infrastructure, raised \$318M in growth equity to support production and certification of aircrafts as well as charging infrastructure build-out
- **OpenAirlines**, with flight operations and emissions optimization software, closed \$47M from Eiffel Investment Group and Mirova to expand product portfolio and perform strategic acquisitions

Q4 saw nearly the same number of PIPE investments as the first three quarters of 2024 combined—the majority from eVTOL innovators in response to recent announcement of enabling regulation

- **Archer Aviation**, announced \$430M to develop electric aircrafts
- **Vertical Aerospace** closed \$180M to support its business operations and continue pursuing commercialization plans
- **Joby Aviation** secured \$500M for aircraft manufacturing and certification

EV Charging: large-scale infrastructure build-outs continued to attract late-stage funding across geographies, while charging management and grid integration solutions primarily attracted early-stage funding

- **Terra Charge** closed \$63M in growth equity to deploy EV charging network across Japan
- Based in Australia, **JetCharge**, developer of EV charging infrastructure, raised \$45M in Series C financing to expand charging network and develop suite of proprietary charging components
- **V2C**, developer of EV charging with load management and solar integration, raised \$5m in Seed funding to support growth across European markets

Transportation & Logistics Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Transport & Logistics industry



Recent Published Research

- **Sector Insight:** Sustainable Aviation (Q4 2024)
- **Spotlight Insight:** Electric Motor Innovation (Q3 2024)
- **Spotlight Insight:** Port Decarbonization (Q2 2024)
- **Sector Insight:** Maritime Sustainability (Q1 2024)
- **Spotlight Insight:** AI for EV Charging (Q4 2023)
- **Sector Insight:** Hydrogen for Heavy Duty Transport (Q3 2023)
- **Spotlight Insight:** Grid-Interactive Fleets (Q2 2023)

Upcoming Topics

- **Spotlight Insight:** Supply Chain and Material Traceability (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** –North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Nicole Cerulli

- Focused on emerging innovation and trends in transportation & logistics.
- Nicole earned an undergraduate degree in Urban Studies and Sustainable Development from Barnard College and a Masters in Urban Resilience Design and Management from Universitat Internacional de Catalunya.

Section 2: Industry Groups

Investment Summary & Activities

Agriculture & Food

Energy & Power

Materials & Chemicals

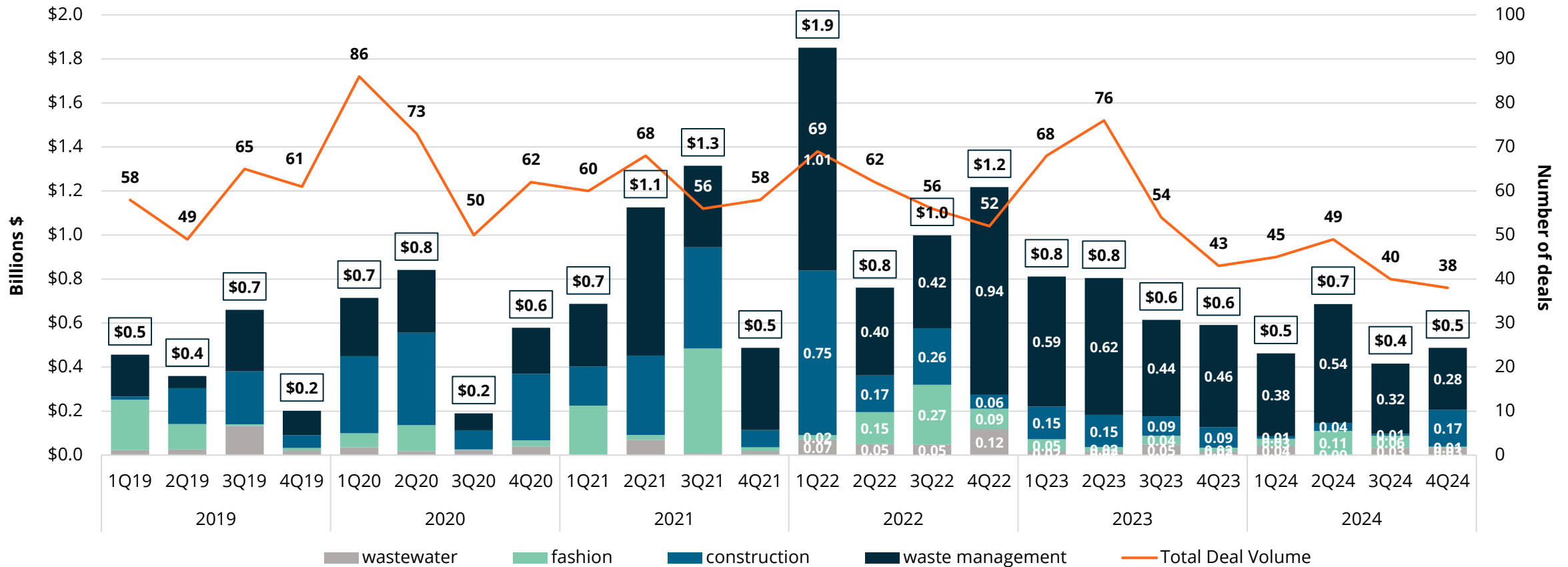
Resources & Environmental Management

Transport & Logistics



Waste & Recycling

Waste & Recycling: 4Q24 Investment Summary



* Excludes deals above \$350M

**Dollars (left) and volume (right) of global cleantech venture capital deal activity

- Waste & Recycling raised \$0.5B over 38 deals in Q4 2024 (excluding outliers). Total funding picked up a bit after a low Q3 where investment fell below \$0.5B for the first time since Q3 2020. Late-stage deals drove total investment amount, with declines across early-stage activity.
- Top line investment figures for *Construction* exploded by 1700% due largely to a \$108M growth round by Gropys. Further, automation and software solutions are being implemented into construction supply chains and management platforms, and a trend to watch in 2025.
- After two years of aggressive capital being poured in *Waste Management*, total investment amount has now declined in two subsequent quarters due to low technological differentiation and profitability amongst innovators in battery, plastic, and textile recycling.

Waste & Recycling: 4Q24 Activities

Corporates, Investors, Ecosystem

Corporates:

- **Amazon** and Techstars led Molg's \$5.5M Seed round commercializing their electronic waste disassembly and robotics solutions
- **Honda** began a joint venture with **Asahi Kasei** to commercialize novel lithium-ion battery separator materials under the banner of Asahi Kasei Honda Battery Separator Corporation in Port Colborne, Ontario, Canada

Investors:

- **Venture Kick** led Seed rounds in WasteFlow's AI-enabled waste sortation product suite as well as Grensol's automobile photocatalysis recycling solutions
- **NFX** led Constrafor's \$14M Series A round commercializing construction finance technologies in addition to Lumen Orbit's \$11M Seed round optimizing data center construction

Entrepreneurial Support Organizations:

- **TechStars** organized Seed rounds and accelerator programs for Envicore's mine tailings valorization technologies and Movopack's Italian expansion for reusable e-commerce packaging

Public Sector:

- **Innovate UK** distributed grants to food waste upcycler Huid, construction automation developer Automated Architecture (Auar), and textile waste traceability firm Truss
- The **US Department of Energy (DOE)** announced a \$20M grant for Furno's eight carbon neutral cement kilns in Chicago as well as a \$20.3M grant for Moment Energy's EV battery recycling operations

Innovators

Construction: diversified growth across automation, supply chains, and materials prompts uptick in investor interest

- Austrian construction software developer **Gropys** raised \$108M in growth equity refurbish their Riehen wall and ceiling manufacturing plant with robotics, automating 86% of tasks
- Supply chain platform **Constrafor** announced a \$250M debt agreement to expand their technology offerings, creating a vertically integrated operations software solution for cash flow, supply chains, and operations
- **Paebbl**, a carbon negative construction material start-up, raised a \$24M Series A to supply first commercial-scale orders and test new application markets

Sorting & Collection: innovators tweaking business models at first-of-a-kind facilities

- **AMP**, developer of automated sortation facilities, raised a \$91M Growth Equity round to deploy their first selection of automated sortation facility partnerships following their pivot from stand-alone robotics
- Chicago-based waste-to-value firm, **Nexus W2V**, raised a \$75M Growth Equity round to sort and convert organic waste into natural gas in La Porte, Indiana

Battery Recycling: novel recycling technologies garnering subsector's largest seed and Series A investments

- Hydrometallurgical battery recycler, **tozero**, increased their previous Seed round with a further \$11.6M to finalize their initial commercial facility after successful material use in lithium-ion battery manufacturing
- Battery recycler **DEScycle**, raised a \$12.7M Series A round to commercialize their Deep Eutectic Solvent technology recycling copper, palladium, and gold in Teesside

Waste & Recycling Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Resources & Environmental Management industry



Recent Published Research

- **Spotlight:** Solvent Dissolution (Q3 2024)
- **Baseline Study:** The Emerging Blue Economy (Q3 2024)
- **Insight:** Battery Recycling (Q2 2024)
- **Insight:** Water Harvesting & Purification (Q3 2024)
- **Insight:** Plastic Recycling (Q1 2024)
- **Spotlight Insight:** Wildfire Risk & Resilience (Q1 2024)
- **Spotlight Insight:** Mining Exploration – Impact Reduction & Avoidance (Q4 2023)
- **Insight:** Marine Carbon Dioxide Removal (Q4 2023)
- **Spotlight Insight:** Biodiversity & Ecosystem Monitoring (Q3 2023)

Upcoming Topics

- **Insight:** Geoengineering (Q1 2025)
- **Spotlight:** PFAS Removal (Q1 2025)
- **Insight:** Insurance & Cleantech (Q1 2025)

Upcoming Events

- **Cleantech Forum North America** –North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Lead Analyst – Holly Stower

- Focused on emerging innovation & trends across resources and environmental management and waste industry groups, including water, waste, circular economy, natural resources, oceans & corporate sustainability.
- Leading Cleantech Group's blue economy Strategic Intelligent Service, our cross-sectoral research including active engagement with the innovators and key stakeholders that are catalyzing business opportunities, through an annual membership
- Prior to joining Cleantech Group, Holly was a Public Affairs & Communications Executive with the Solar Trade Association & the Association of British Insurers.
- Holly earned Undergraduate & Masters degrees in Environmental Science from the University of East Anglia.

Waste & Recycling Research

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world shaping the future of the Waste & Recycling industry



Recent Published Research

- **Sector Insight:** Textile Recycling (Q4 2024)
- **Spotlight Insight:** Solvent-Assisted Plastic Recycling (Q3 2024)
- **Sector Insight:** Battery Recycling (Q2 2024)
- **Sector Insight:** Plastic Recycling (Q1 2024)
- **Spotlight Insight:** Residential Heat Pumps (Q4 2023)
- **Spotlight Insight:** Cultivated Protein (Q4 2023)
- **Sector Insight:** Critical Metals Sustainability (Q2 2023)
- **Spotlight Insight:** Cathode Manufacturing (Q2 2023)

Upcoming Topics

- **Spotlight Insight:** PFAS Removal (Q1 2025)
- **Sector Insight:** Wastewater (Q2 2025)

Upcoming Events

- **Cleantech Forum North America** – North America – San Diego, CA – January 27-29, 2025
- **Cleantech Forum Asia** – Singapore – May 6-7, 2025

Associate Analyst – Parker Bovée

- Focused on emerging innovation & trends across cleantech sectors, including water management systems and recycling technology.
- Prior to joining Cleantech Group, Parker developed wildfire prevention technologies with VegaMX and researched wildfire management at Duke University and the University of California, Berkeley.
- Parker earned a Bachelor's degree in History and Public Policy from the University of California, Berkeley where he specialized in the history of American environmental entrepreneurship.

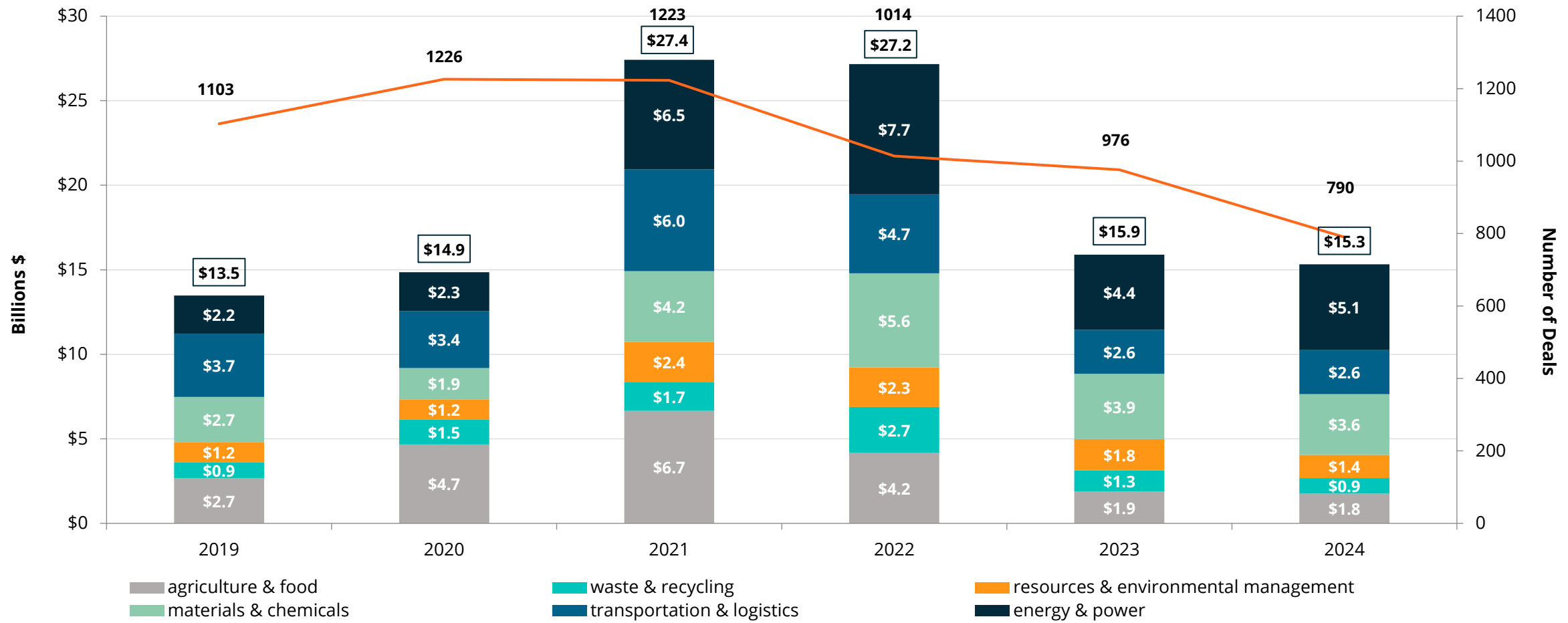
Section 4: Geographic Breakdown

Investment Summary & Activities

 North America

Cleantech Deal Amount and Volume: North America

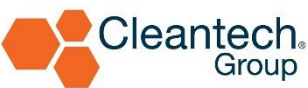
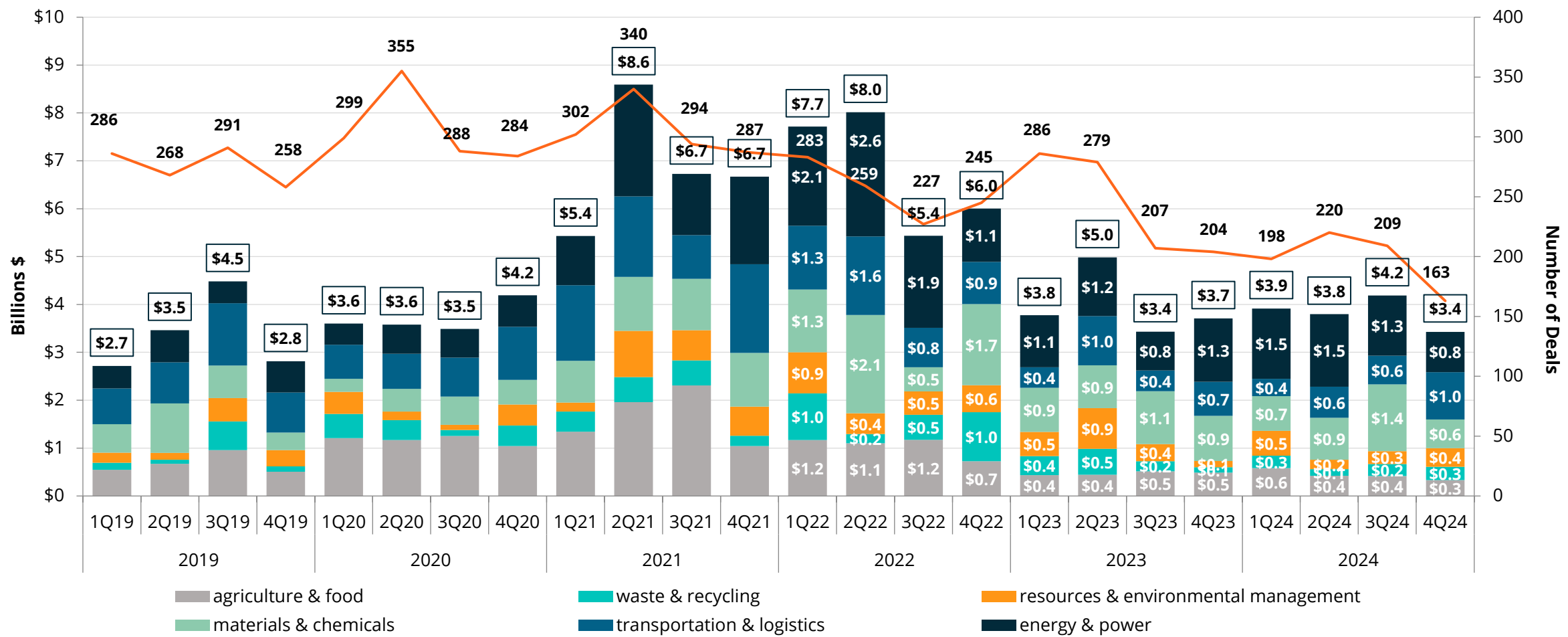
At \$15.3B invested over 790 deals in 2024, North America settled around 2023 figures despite generating fewer deals. The region's Energy & Power innovators raised 16% more this year, led large rounds across *energy storage (batteries)*, *hydrogen*, and *energy efficient* computing solutions for data centers. Globally, United States led investments for *carbon capture usage & storage* (\$704M), making up 12% of \$15.3B for North America. This flow of capital has been incentivized by supportive carbon-capture related policies and publicly funded pilot programs established by both the US and Canadian governments in 2024.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deal Amount and Volume: 4Q24 North America

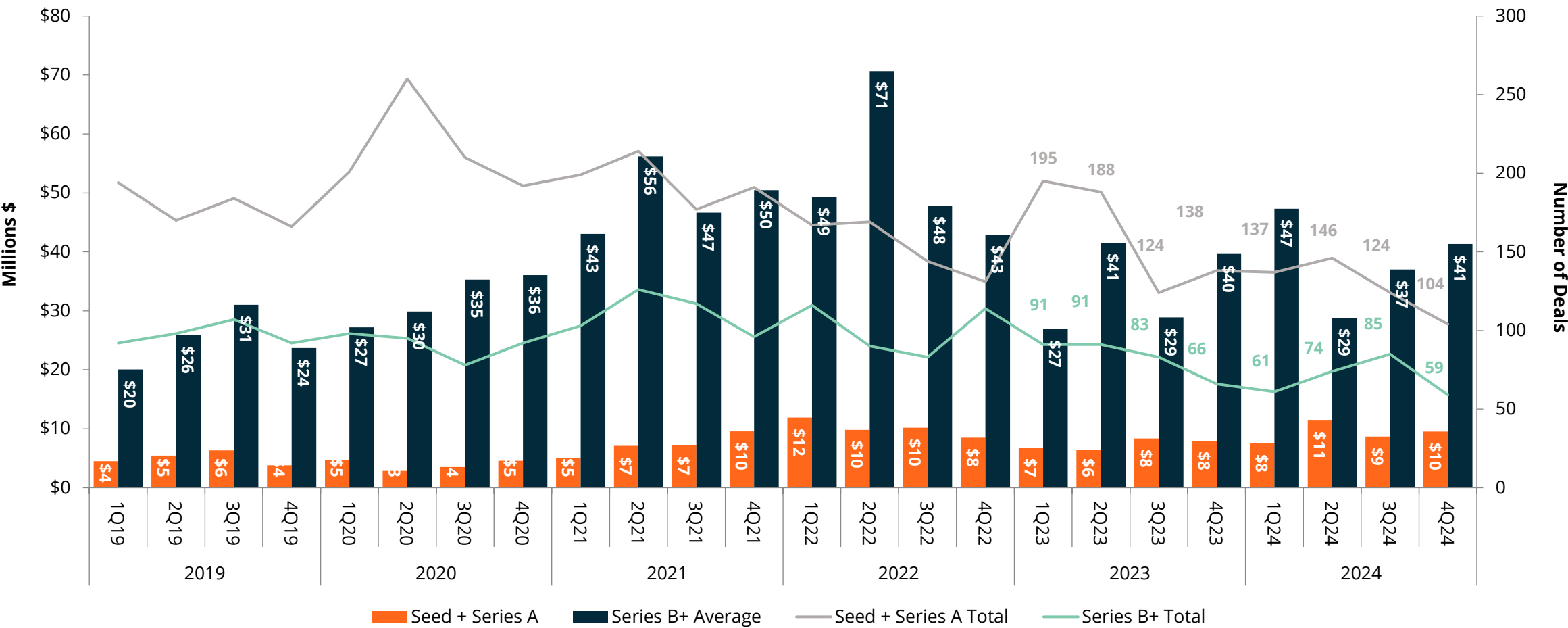
North America closed Q4 with a near 20% decrease by both amount invested, and deal volume compared to Q3. *Aviation* racked up \$620M in funding this quarter, up by 560% compared to Q3 and driven by four large rounds raised by eVTOL and sustainable spacecraft developers. Q4 included outlier investments above \$350M in *nuclear fusion & fission, SMRs and energy efficient computing*, with publicly-funded research and innovation initiatives aligned to these sectors rolled out in the latter half of 2024.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deals by Stage: 4Q24 North America

The region experienced a dip in average late-stage deal size in Q4. Several large-scale growth equity deals in Transportation & Logistics raised the industry group’s average deal size to an all-time-high this quarter despite lower deal volume. Electric *aviation* innovators Beta Technologies and Boom Supersonic helped to drive this growth, whose rounds focus on ramping up production to meet growing demand, supportive policies, and infrastructure development (ie charging stations, electric grids).



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

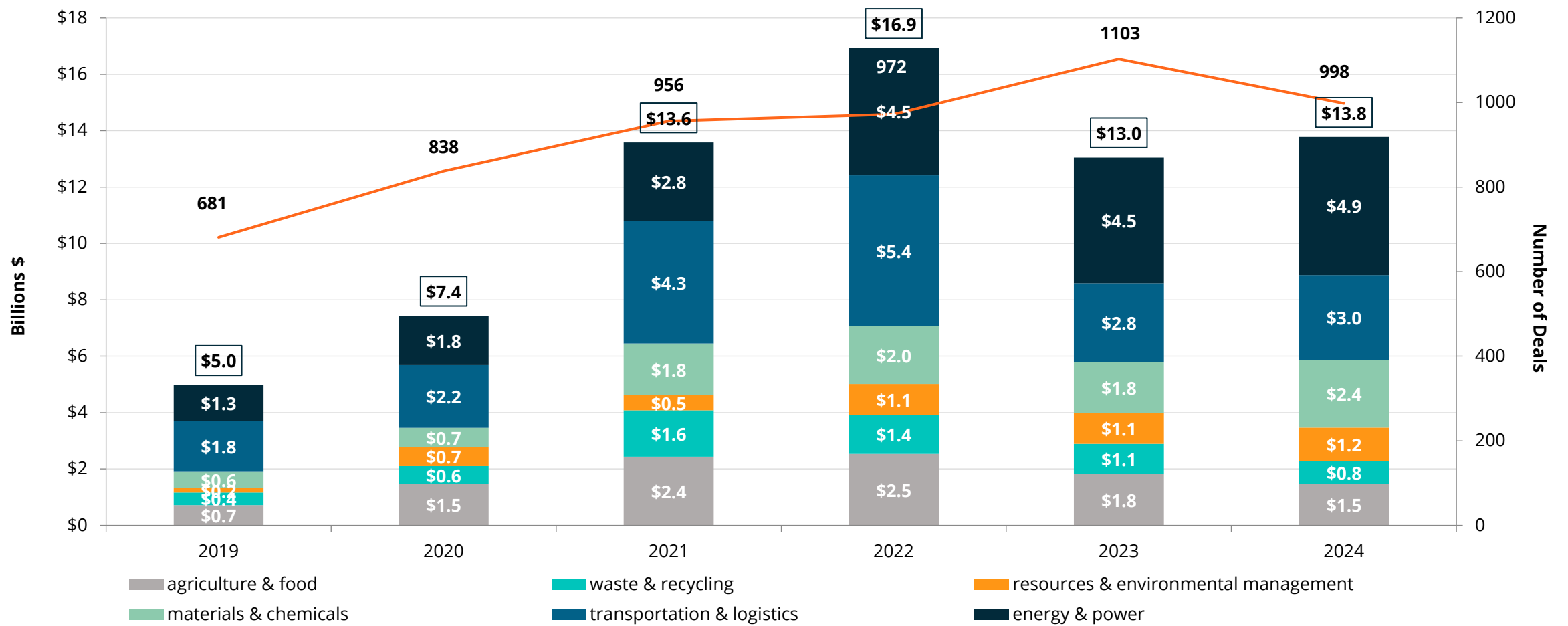
Section 4: Geographic Breakdown

Investment Summary & Activities



Cleantech Deal Amount and Volume: Europe

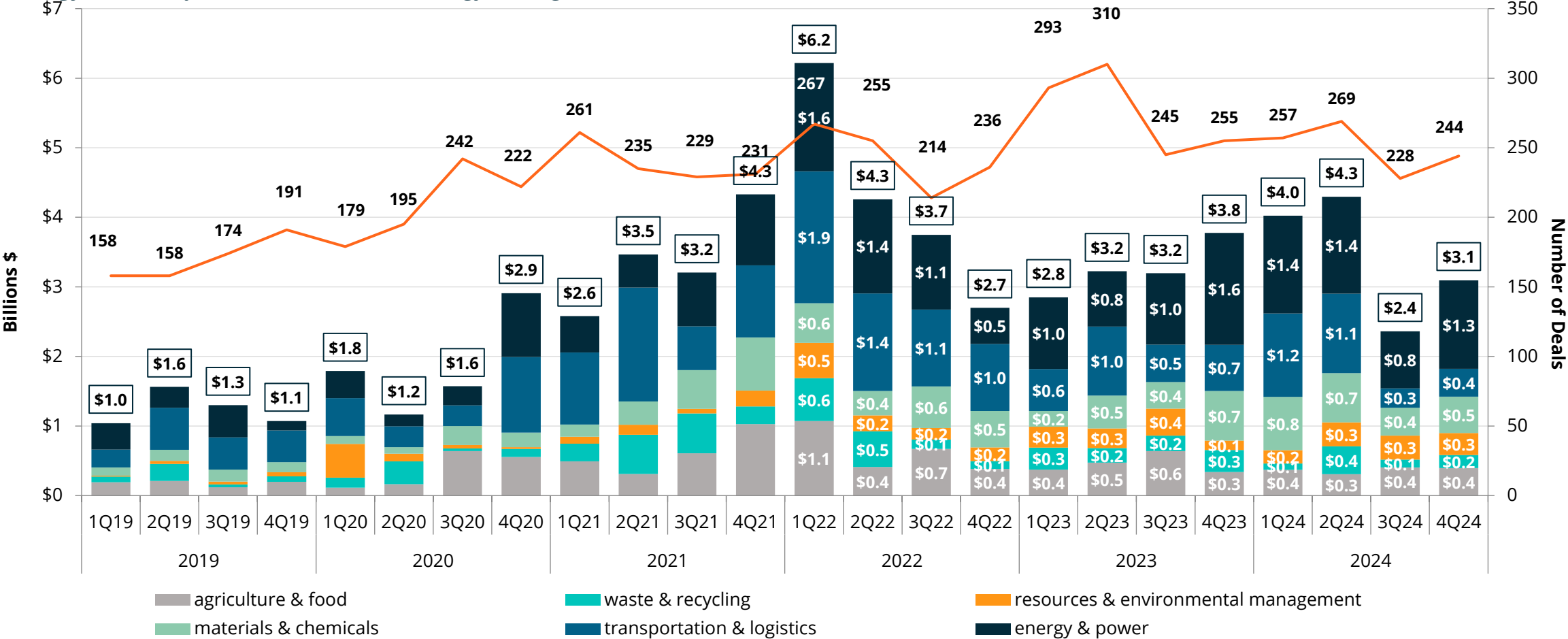
Europe wrapped up 2024 with a strong finish of \$13.8B raised over 998 deals, just surpassing levels achieved in 2023. Energy & Power grew by 8% reaching a record high amount (\$4.9B, excluding outliers) led by large rounds in *hydrogen* and *nuclear fusion*. Funding for *energy storage* increased by 35% despite consistent deal volume levels from 2023, as the region boosts renewables penetration and looks to innovative storage technologies to solve the structural challenges that come with this shift. Materials & Chemicals was the only industry group that saw increases in the volume of investments in *fuels & chemicals* and *advanced materials* from last year.



*Excludes outlier deals above \$350M
**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deal Amount and Volume: 4Q24 Europe

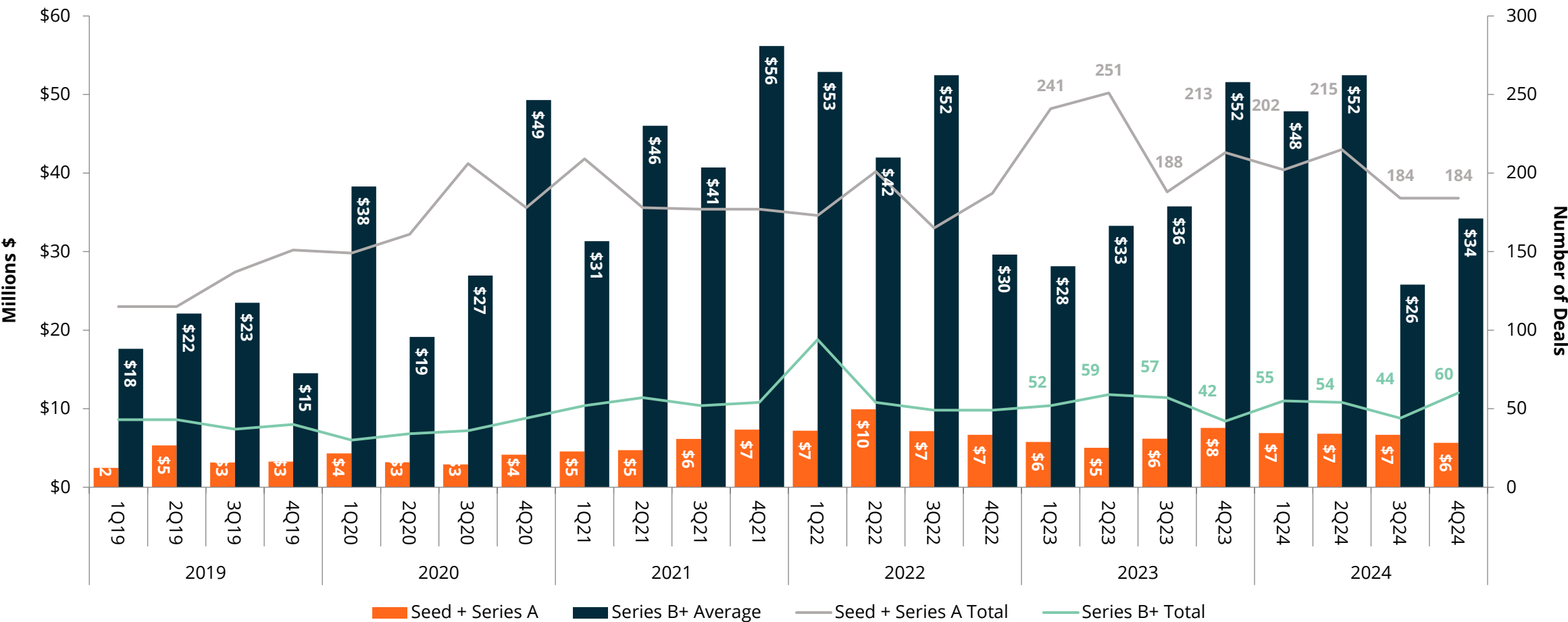
Q4 venture funding increased by 29% with \$3.1B raised over 244 deals as activity cools off after the surge in giga rounds from the end of 2023 into the first half of the year. This increase was led by Energy & Power investments, with 40% of its total funding comprised of four large (above \$100M) deals raised by 1Komma5 (*buildings*) leading noticeable growth for the sector as the region as energy management software developers prepare for new phases of growth; followed by Elyse Energy (*hydrogen*), Tokamak Energy (*nuclear fusion*) and Inobat (*energy storage*).



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deals by Stage: 4Q24 Europe

Average late-stage deal size increased by a noticeable 30% from Q3 to Q4 as innovators accelerate commercialization through larger Growth Equity rounds. Q4 activity brought late-stage deal volume to its highest point this year with innovators developing *energy management* and *environmental monitoring* platforms prepare to expand into new markets in 2025, reflecting the region's overall sustained interest throughout the year in software-based and AI-driven technologies.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

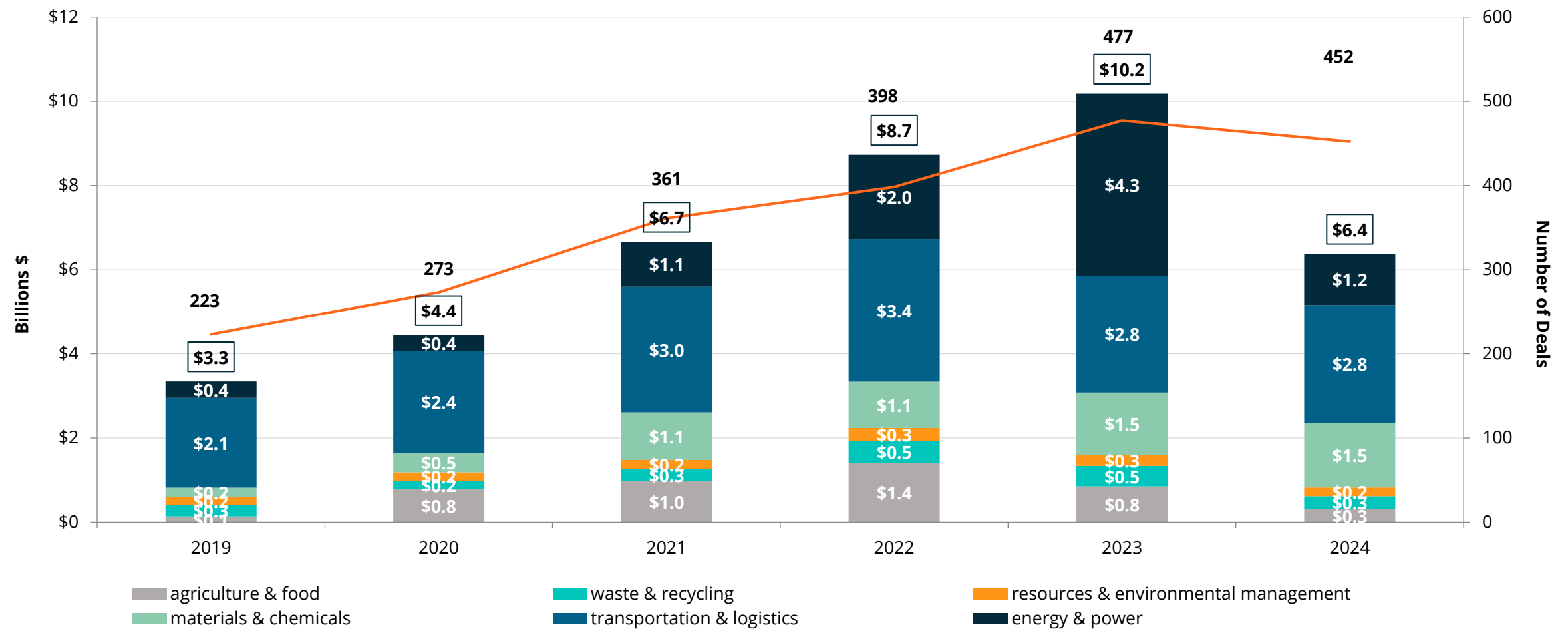
Section 4: Geographic Breakdown

Investment Summary & Activities

 Asia Pacific

Cleantech Deal Amount and Volume: APAC

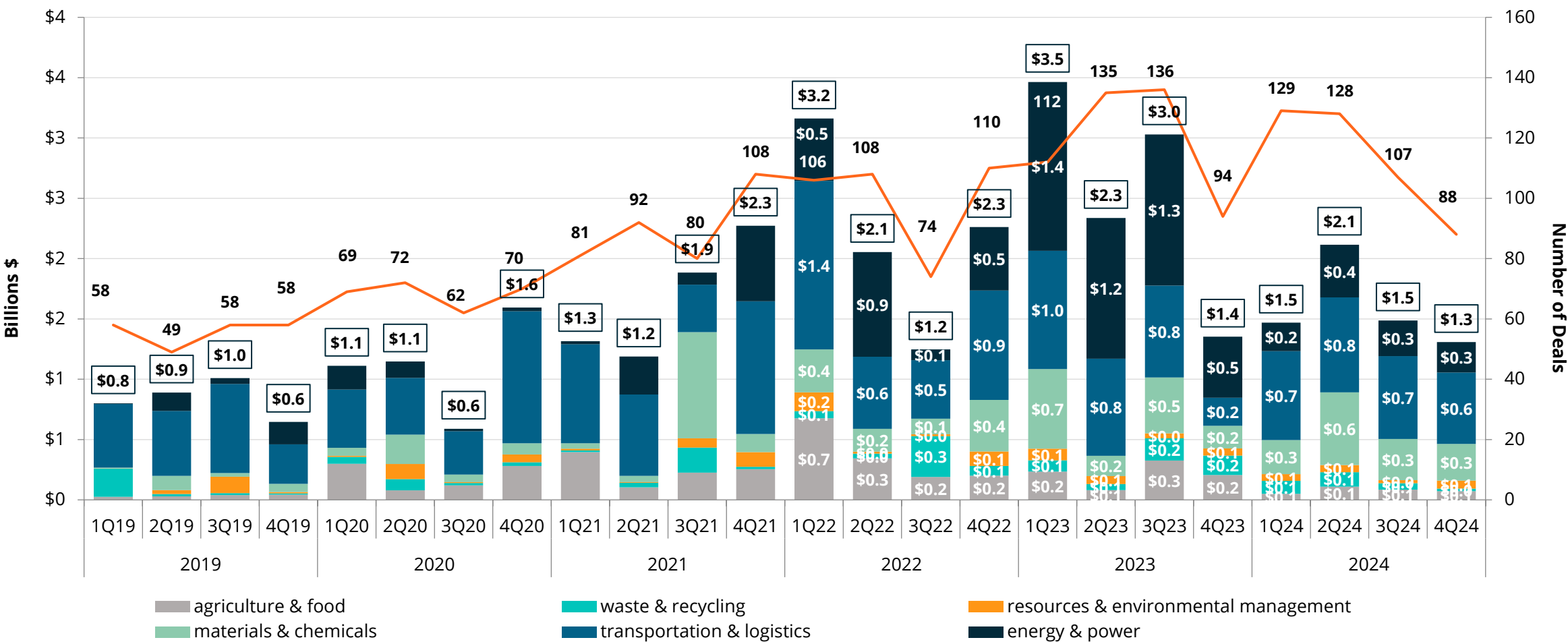
Asia Pacific ended 2024 with \$6.4B raised over 452 deals, a drop in investment amount from 2023. Overall deal count is consistent with 2023 levels as last year's deal volume drivers Energy & Power and Transportation & Logistics cooled off and Materials & Chemicals saw a noticeable uptick in early-stage funding earlier this year. *Advanced energy materials* generated the highest total funding amount with investments in historically high-performing sectors like *batteries* and *semiconductors* shifting focus from product components to manufacturing technology to further strengthen their role presence along the supply chain.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deal Amount and Volume: 4Q24 APAC

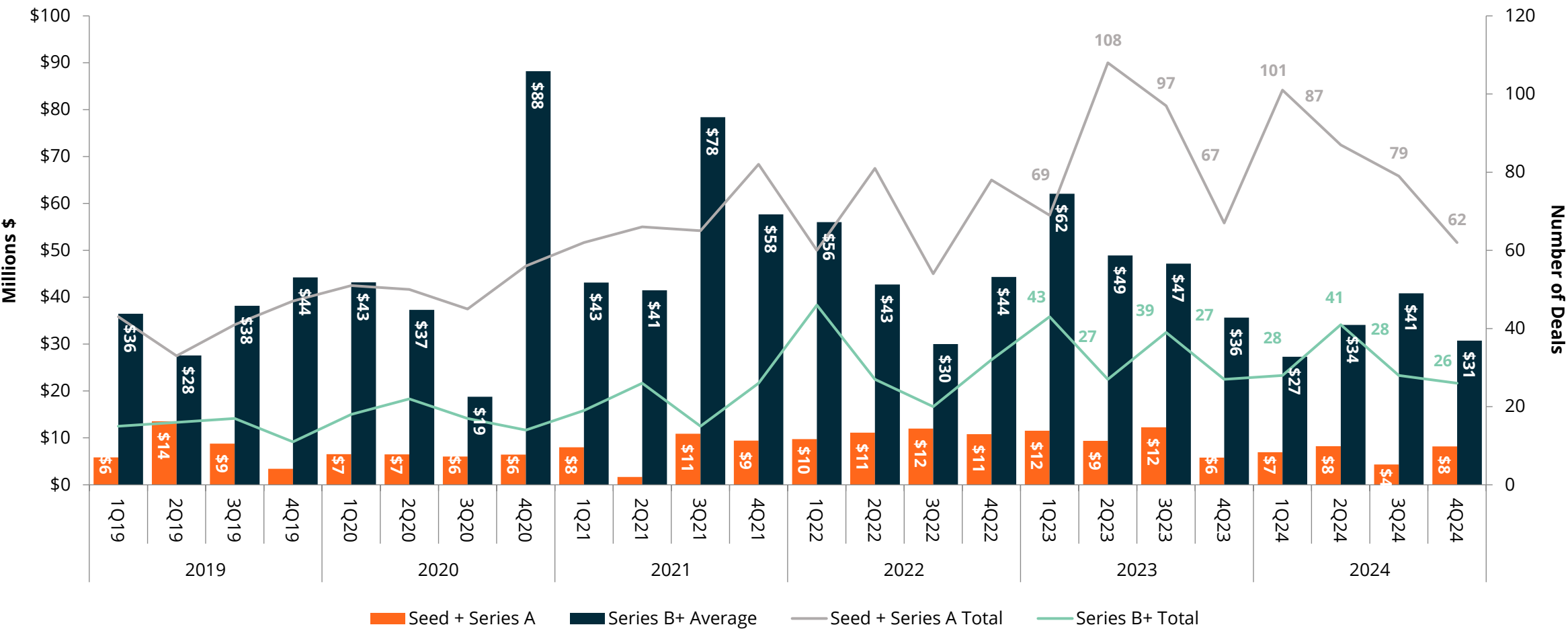
APAC generated \$1.3B raised over 88 deals in Q4, settling into similar activity level from 4Q23 onwards. *On-road vehicles* dominated the quarter's deals by total amount, led by large rounds (over \$100M), including Avatr's \$1.5B outlier round. *Advanced energy materials, energy storage* and *aviation* led by deal volume activity, with the latter's investment amount falling significantly from Q3's levels as newer developers still pursue further product research and testing as they focus on obtaining initial certification.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

Cleantech Deals by Stage: 4Q24 APAC

Early-stage deal volume continues to fall in Q4, with a 30% decrease in Seed rounds contributing to a 21% decrease overall from Q3. Average early-stage deal size bounced back after experiencing a slight dip in Q3, driven up by Alcohol Hydrogen Technology's \$135M Series A round. Average Series A deal sizes increased by 49% from Q3 to Q4 to its highest point in 2024 as *on-road vehicles, electronics* and *additive manufacturing* innovators look to expand their product offerings scale product research and development.



**Dollars (left) and volume (right) of global cleantech venture capital deal activity
*Excludes outlier deals above \$350M

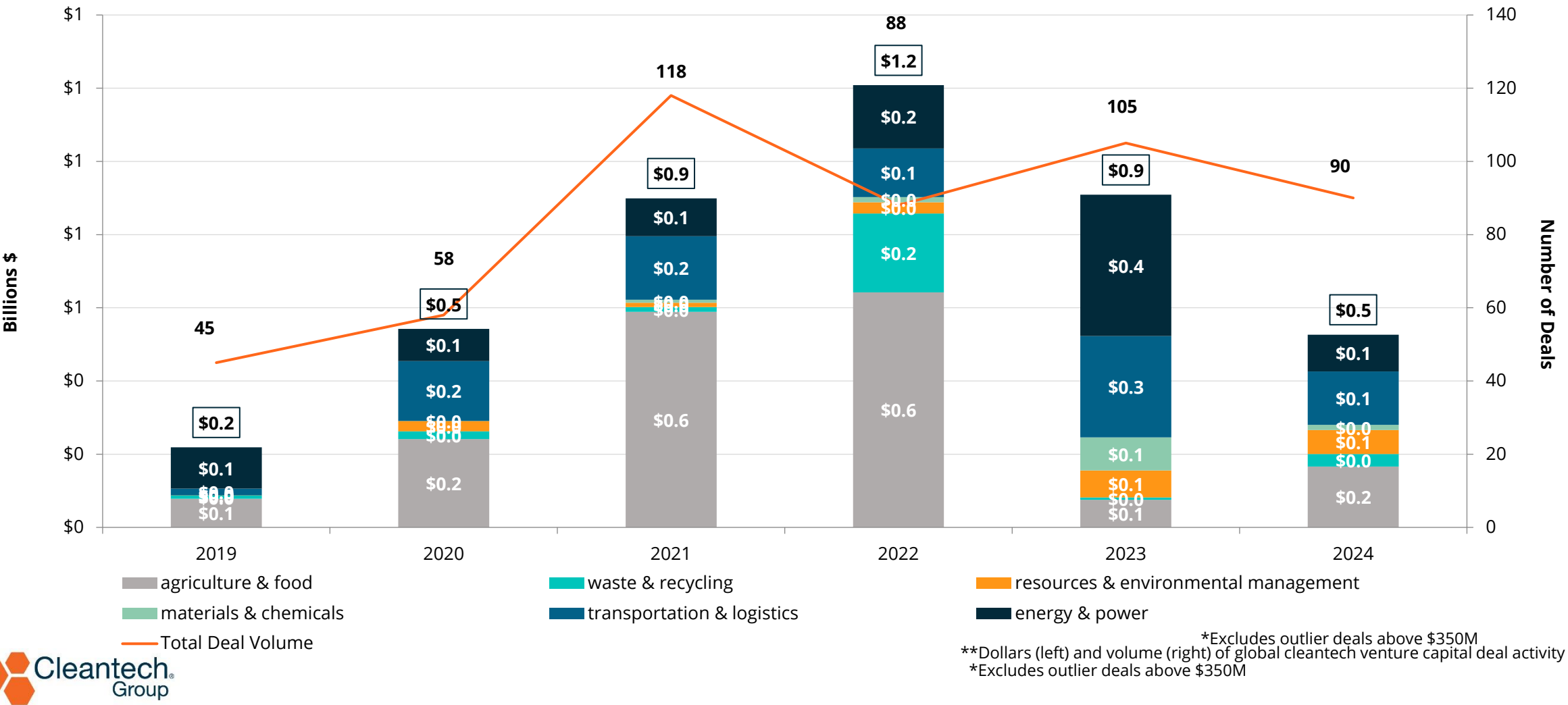
Section 4: Geographic Breakdown

Investment Summary & Activities

 Rest of the World

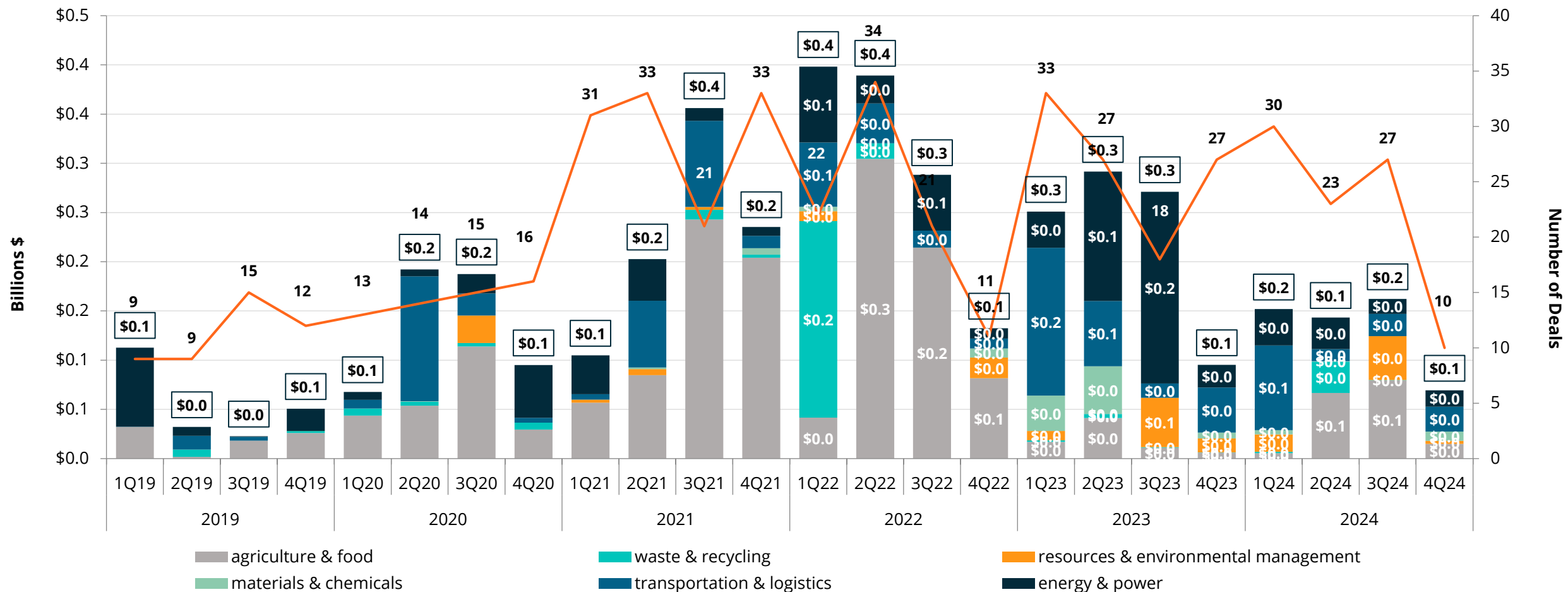
Cleantech Deal Amount and Volume: RoW

Q4 activity closes out the region's 2024 activity with \$562M raised across 90 deals, a 50% decrease in investment amount from 2023. Some of the quarter's larger deals centered around *buildings* innovators providing energy management systems look to expand distribution and develop additional platform capabilities. However, 2024's overall decrease in activity discounts Scala's outlier \$550M growth equity round supporting the company's regional expansion.



Cleantech Deal Amount and Volume: 4Q24 RoW

Total deal volume in the region dipped slightly from 2023's numbers, with Agriculture & Food continuing to dominate deal count. Most of the region's Q4 deals centered *on-road vehicles* this quarter as electric vehicle developers in Kenya, Rwanda and Senegal sought ramp up vehicle production and accelerate fleet management capabilities.



Data & Ecosystems

Cleantech Group tracks the start-ups, scale-ups, investors & multinationals from across the region & the world. Data & Ecosystems leverages this data to derive insights on global innovation ecosystems.



Associate Analyst – Sasha Bukhari

- Focused on mapping ecosystem data and contributing to consulting and research projects across Cleantech Group's industry groups.
- Leading Cleantech Group's Data & Ecosystem team, Sasha manages Cleantech Group's Monitor's i3 database, leveraging data analytics to deliver the Quarterly Investment Insight, alongside various reports. Sasha collaborates with the development team to further i3's features and data coverage.
- Sasha has a B.Sc. in International Political Economy from the City University of London and has completed a dissertation project on the relationship between renewable energy and the impact that a transition away from fossil fuels will have on social landscapes. The project connects energy centralization to corporate hierarchies and power distribution.



Analyst – Arianna Bernas

- Focused on managing and developing Monitor's i3 database and cleantech ecosystem, working with the development team to enhance i3's data coverage, quality of data, and platform's features
- Arianna develops the Quarterly Investment Insight and works with the wider team to leverage i3's data analytics for CTG's various reports, research, and consulting projects.
- Arianna has an MSc in Climate Change Finance & Investment from the University of Edinburgh, where she primarily focused on GHG emissions accounting and corporate transition planning. She has a B.A. in International Development Studies with a minor in Philosophy from Bryn Mawr College. She has previous experience in both traditional advertising and digital marketing.

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