PitchBook

EMERGING TECH RESEARCH

Clean Energy Report

VC trends and innovation spotlights

Q3
2024

Contents

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Published on November 22, 2024

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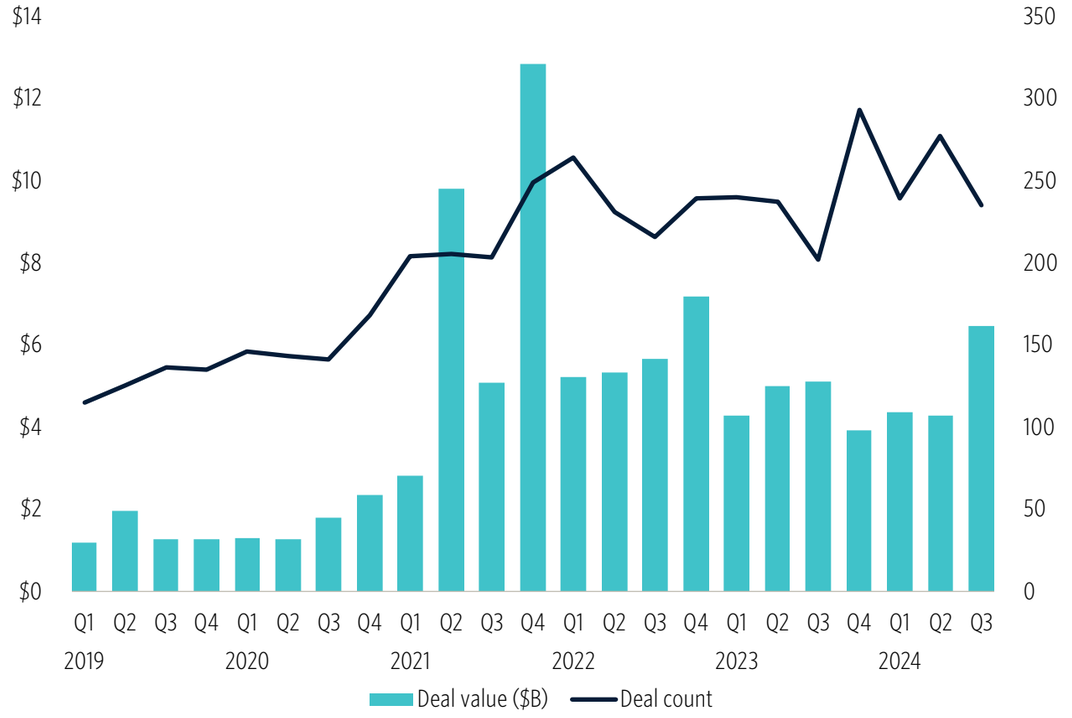
Vertical update

VC investment in clean energy technologies grew to $6.4 billion in Q3 2024, bolstered by two large deals for East Asia-headquartered hydrogen technology developers. Q3 saw a continuation of strong VC investment in battery energy storage and solar photovoltaic technologies in addition to grid management technologies outside of battery energy storage.

In Q3, Form Energy—one of the largest VC-backed developers of nonlithium batteries—announced the start of a production trial at its first large-scale battery production factory in West Virginia. Following this, the US Department of Energy (DoE) announced funding for multiple energy storage projects, including two iron-air long-duration energy storage systems developed as a collaboration between Form Energy and Xcel Energy.[1] The quarter also saw high VC deal value flow into companies developing nuclear fusion technologies, resulting in the strongest quarter for the nuclear fusion category since Q4 2021 when Commonwealth Fusion Systems raised a sizable $1.8 billion Series B. Interest in nuclear fusion has grown in recent years, though the technology approaches in the space are still highly varied with no clear consensus on the most effective approach to generating power from fusion.

Clean energy VC deal activity by quarter



Source: PitchBook • Geography: Global • As of September 30, 2024

1: "Biden-Harris Administration Announces $325 Million for Long-Duration Energy Storage Projects to Increase Grid Resilience and Protect America's Communities," US Department of Energy, September 22, 2023.

VERTICAL UPDATE

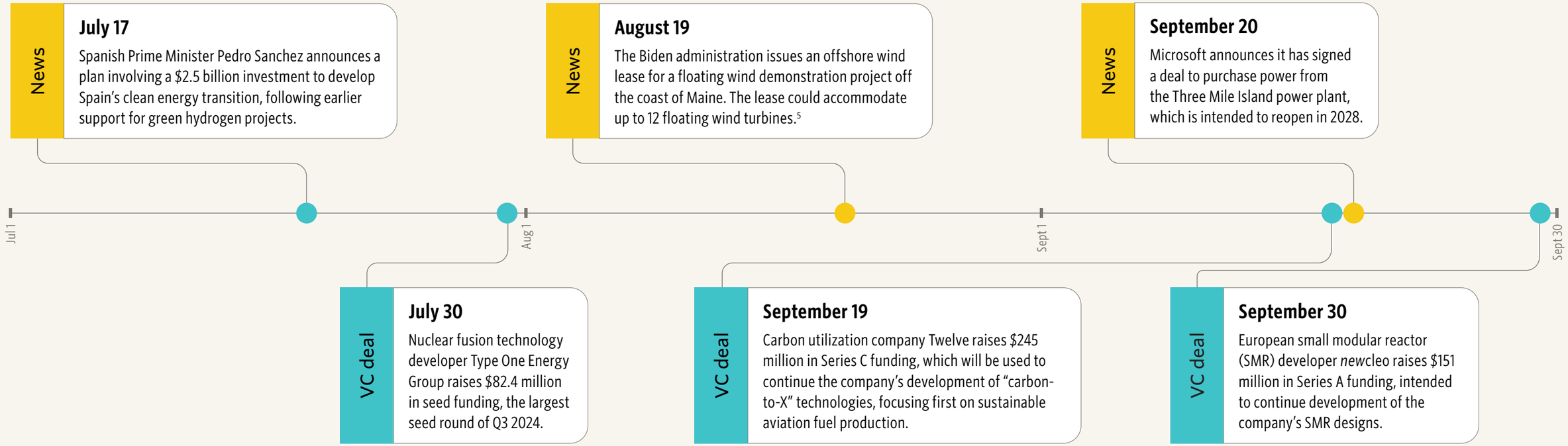
Political uncertainty in the US has been a key theme for the clean energy space in Q3 2024, as many of the incentives supporting clean energy manufacturing and production were introduced by the Biden administration and Republicans have been more critical of clean energy compared to conventional energy sources, as covered in our recent US Presidential Election Guide. US nuclear fission energy has also been seeing renewed interest, with the announcement of plans to reopen the Three Mile Island nuclear power plant—the site of a partial meltdown in 1979—following an agreement from Microsoft to purchase power from the facility.[2] Further, at the end of the quarter, the US DoE made a $1.5 billion loan to reopen Michigan's Palisades Nuclear Generating Station, which closed in 2022.[3]

In Europe, the Norwegian government announced the country's first subsidies—up to $3.3 billion—for floating offshore wind energy, providing additional support for the overall offshore wind sector, which has otherwise faced problematic supply chains and rising costs. Clean fuels have also been in the spotlight, as plans for a low-carbon hydrogen pipeline between western Denmark and northern Germany have been postponed by three years, from 2028 to 2031.[4] Adoption of hydrogen has been hampered by a lack of developed distribution and storage infrastructure. Current applications for hydrogen typically exist as either partnerships between high-volume producers and consumers, or as on-site production for industrial purposes—both of these options reduce the need for widespread distribution networks.

2: "Microsoft Chooses Infamous Nuclear Site for AI Power," BBC, Natalie Sherman, September 20, 2024.
3: "US Closes $1.52 Billion Loan to Resurrect Michigan Nuclear Plant," Reuters, Timothy Gardner, October 1, 2024.

4: "Denmark Postpones Green Hydrogen Transmission Roll-Out to Germany to 2031," Reuters, Louise Breusch Rasmussen and Riham Alkousaa, October 8, 2024.

Q3 2024 timeline



5: "US Issues Floating Wind Research Lease to State of Maine," Reuters, Nichola Groom, August 19, 2024.

Clean energy VC deal summary

	Quarterly activity					Trailing 12-month activity	
	Q3 2023	Q4 2023	Q1 2024	Q2 2024	Q3 2024	Q4 2022 to Q3 2023	Q4 2023 to Q3 2024
Deal count	**202**	**293**	**239**	**277**	**235**	**918**	**1,044**
QoQ change	-14.8%	45.0%	-18.4%	15.9%	-15.2%	N/A	13.7%
Share of total VC	2.1%	2.9%	2.4%	2.9%	2.8%	2.0%	2.8%
Deal value ($B)	**$5.1**	**$3.9**	**$4.4**	**$4.3**	**$6.4**	**$21.6**	**$19.0**
QoQ change	2.4%	-23.5%	11.2%	-1.7%	50.7%	N/A	-11.9%
Share of total VC	6.3%	4.8%	5.2%	4.6%	7.4%	6.0%	5.5%
Exit count	**6**	**10**	**11**	**9**	**4**	**38**	**34**
Public listings	4	2	1	4	1	10	8
Acquisitions	2	7	6	5	2	21	20
Buyouts	0	1	4	0	1	7	6

Source: PitchBook • Geography: Global • As of September 30, 2024

Clean energy landscape

1. Intermittent renewable energy sources
2. Dispatchable energy sources
3. Clean fuels
4. Grid infrastructure

Clean energy VC ecosystem market map

This market map is an overview of venture-backed or growth-stage companies that have received venture capital or other notable private investments as of Q3 2024.

Click to view the latest interactive map on the PitchBook Platform.

1 Intermittent renewable energy sources

Solar photovoltaic (PV)

nexamp, HUASUN, Tianjin Clean Energy, Huakong Power, CHNT, d.light, 1KOMMA5°, aurora, ASTRONERGY

Solar thermal

BrightSource, GlassPoint, newheat, ecoworks, Naked Energy., Synhelion, TVP SOLAR, solarus, CosinSolar, heliac

Wind

ONE POWER COMPANY, SKYSPECS, RADIA, ALTAEROS, XOCEAN, Beam, EWT, UPC Renewables, HYDRO WINDENERGY, AERONES

2 Dispatchable energy sources

Geothermal

FERVO, Eavor, BASELOAD CAPITAL, CONTROLLED THERMAL RESOURCES, QUAISE, Lithium de France, XGS, zanskar

Hydropower

NHC, Natel, Anzana Electric Group, PANTHALASSA, CorPower Ocean, ORBITAL, sweetch energy, VerdantPower, NLINEENERGY

Nuclear fission

TerraPower, energy, newcleo, TERRESTRIAL, LAST ENERGY, RADIANT

Nuclear fusion

tae, HELION, generalfusion, ZAP ENERGY, Tokamak Energy, NeoFusion, first light, MarvelFusion

3 Clean fuels

Hydrogen

Mobil Green Energy, ELECTRIC HYDROGEN, sunfire, monolith, TES, ohmium, KOLOMA, Ambient Fuels, FIRST ELEMENT FUEL

Biofuels

Renmatix, Edeniq, DUCTOR, Reverion, JOI, Bioo, ClearFlame, Glanua

Waste to energy/fuel

Enerkem, ecocere, PERPETUAL NEXT, Braven, INENTEC, AIREX ENERGY, nexus CIRCULAR, LANZAJET, Fiberight, SIERRA ENERGY

Clean conventional fuels

twelve, ESG CLEAN ENERGY, INERATEC, ClearSky Global, PROMETHEUS, Blue World, CARBON RECYCLING INTERNATIONAL, M2X, Electrochaea, Upstart Power

4 Grid infrastructure

Battery storage

northvolt, SVOLT, Form energy, Sila, HTHIUM, 24M, ZENERGY, ENERVENUE, one

Nonbattery storage

Highview Power, skeleton, ANTORA, RONDO, accenta., ecozen, MALTA, ENERGYDOME

Analytics & grid management

Brighte, swell, Mainspring, FREEWIRE, PEAK POWER, VELCO, menlomicro, Gangneng Investment Group, iGRID SOLUTIONS

VC activity

VC deal value invested into clean energy technologies grew 50.7% QoQ in Q3 2024, from $4.3 billion to $6.4 billion. This puts quarterly deal value at its highest point since Q4 2022, which saw 14 deals larger than $100 million, including Northvolt's $1.1 billion late-stage round. In contrast, only seven deals in Q3 2024 exceeded $100 million, although two companies raised $1 billion or more: Mobii Green Energy raised a $2 billion late-stage round and China Hydrogen Energy Technology Company raised a $1 billion late-stage round. The companies are headquartered in Taipei and Beijing, respectively. These two deals are a major factor in Q3 2024's high deal value, which is the fourth highest of any quarter on record.

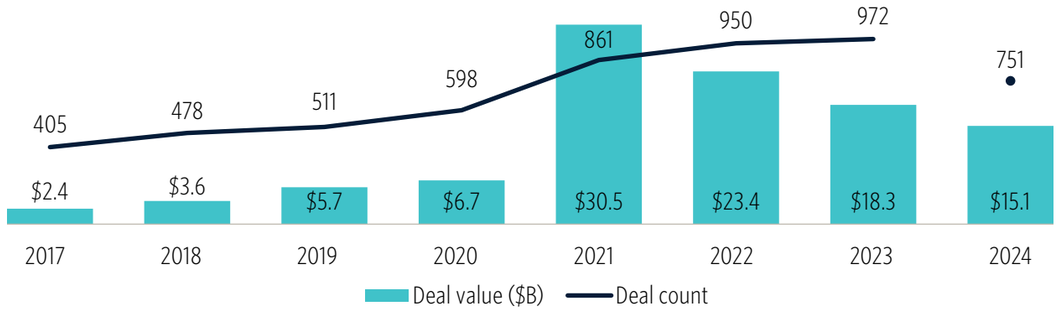
Deal count fell QoQ in Q3, from 277 to 235, though we have seen deal counts remain somewhat steady since Q4 2021, fluctuating around an average of 244 per quarter since. This strong quarterly performance has pushed the 2024 YTD VC deal value to $15.1 billion, compared to $18.3 billion across 2023, putting the clean energy space on track to exceed 2023's deal value. Three quarters into the year, median deal value remains somewhat flat, rising very slightly to a new high of $6.3 million from $6.2 million in 2023 and $6.1 million in 2022. Median pre-money valuations fell from a record high of $30.5 million in 2023 to $23 million by the end of Q3 2024, largely due to a fall in early-stage valuations, which fell from $41.5 million to $30 million over the same period. During this time, late-stage VC valuations fell slightly, from $49.5 million to $46.9 million, whilst pre-seed/seed valuations increased from $10 million to $12.2 million, continuing the trend of steady increases of pre-seed/seed valuations from $5.6 million in 2021.

Looking at specific segments within clean energy, the two large hydrogen deals make the clean fuels segment the largest by far, with $4 billion in quarterly deal value. By contrast, the grid infrastructure segment was the next largest in Q3 2024, with $1.2 billion in VC deal value, followed by $818.8 million for dispatchable energy sources and just $497.9 million for intermittent renewable energy technologies like wind and solar. Grid infrastructure is the largest segment of clean energy looking at trailing 12-month (TTM) deal value, at $6.3 billion, followed closely by clean fuels at $6.1 billion and intermittent renewable energy at $5.1 billion. Dispatchable energy sources raised the least TTM VC deal value at only $2.1 billion. Within this segment, however, Q3 2024 saw a high number of deals in the nuclear fusion technologies category for a total of 10 deals, including four larger than $50 million:

- Zap Energy's $130 million Series D
- Type One Energy Group's $82.5 million seed round (the largest seed round of the quarter)
- Kyoto Fusioneering's $82.4 million Series C
- Marvel Fusion's $69.7 million Series B

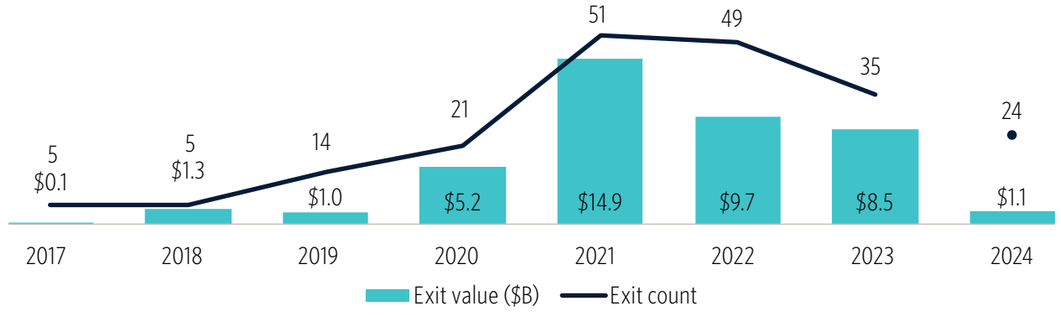
At the end of Q3 2024, exit value in the space reached $1.1 billion, a substantial decline from 2023's $8.5 billion. So far, the largest exits of 2024 include two developers of solar photovoltaic structural hardware: Yonz Technology's $580.8 million exit via IPO and Ojjo's $119 million acquisition by Nextracker. The next largest exit of 2024 was nuclear fission microreactor developer NANO Nuclear Energy's $104 million exit via IPO.

Clean energy VC deal activity



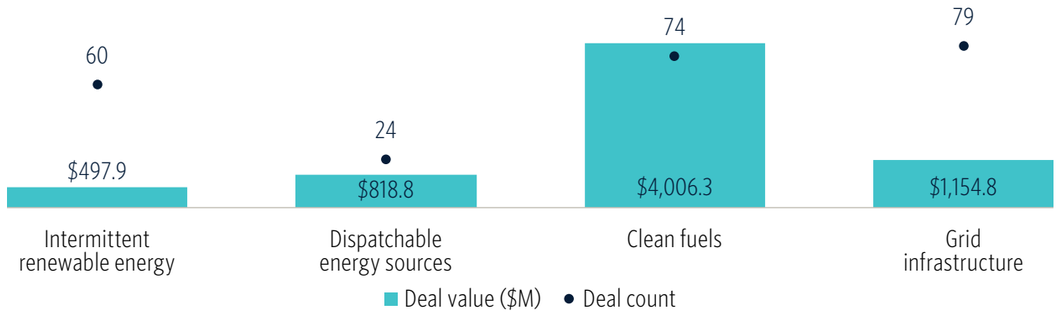
Source: PitchBook • Geography: Global • As of September 30, 2024

Clean energy VC exit activity



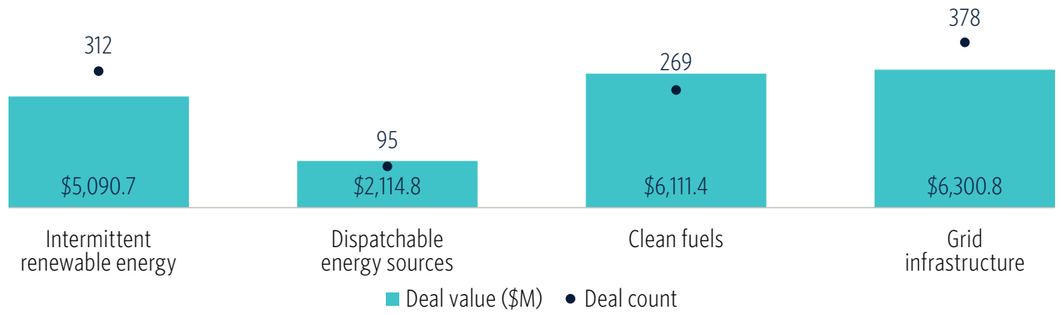
Source: PitchBook • Geography: Global • As of September 30, 2024

Q3 2024 clean energy VC deal activity by segment



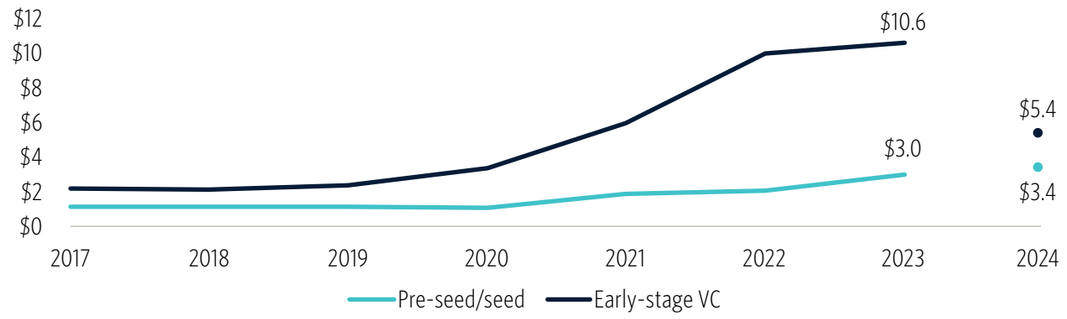
Source: PitchBook • Geography: Global • As of September 30, 2024

TTM clean energy VC deal activity by segment



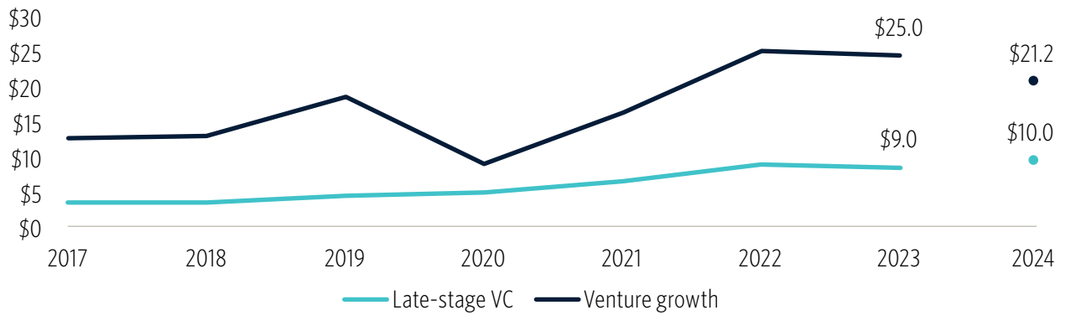
Source: PitchBook • Geography: Global • As of September 30, 2024

Median pre-seed/seed and early-stage VC clean energy deal value ($M) by stage



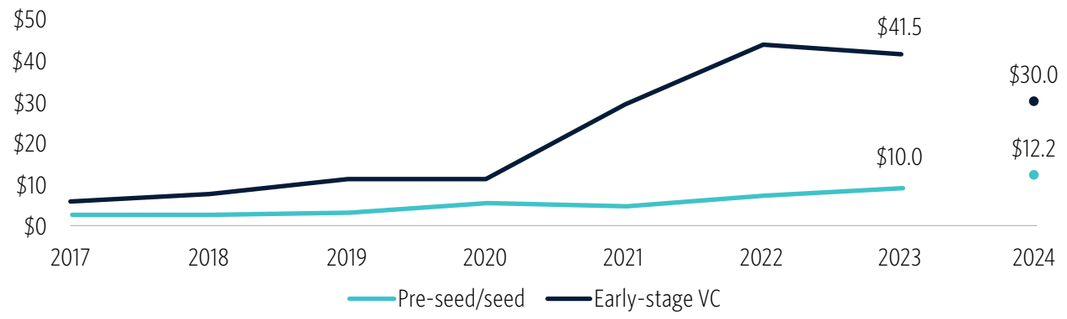
Source: PitchBook • Geography: Global • As of September 30, 2024

Median late-stage VC and venture growth clean energy deal value ($M) by stage



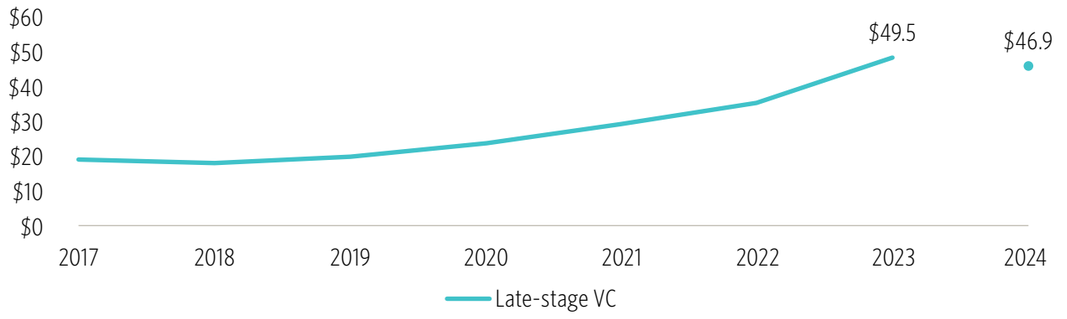
Source: PitchBook • Geography: Global • As of September 30, 2024

Median pre-seed/seed and early-stage VC clean energy pre-money valuation ($M) by stage



Source: PitchBook • Geography: Global • As of September 30, 2024

Median late-stage VC clean energy pre-money valuation ($M) by stage



Source: PitchBook • Geography: Global • As of September 30, 2024

Key clean energy pre-seed/seed VC deals in Q3 2024

Company	Close date	Segment	Category	Deal value ($M)	Post-money valuation ($M)	Lead investor(s)
Type One Energy Group	July 30	Dispatchable energy sources	Nuclear fusion	$82.5	N/A	Breakthrough Energy, Doral Energy Tech Ventures, TDK Ventures
Exowatt	September 10	Intermittent renewable energy	Solar photovoltaic	$20.0	N/A	Andreessen Horowitz, Sam Altman
Splight	July 15	Grid infrastructure	Analytics & grid management	$12.0	N/A	EDP Ventures, NOA Capital
Axle Energy	August 1	Grid infrastructure	Analytics & grid management	$10.5	$29.8	Accel
Enteligent	August 20	Intermittent renewable energy	Solar photovoltaic	$10.4	$33.4	Taronga Group
LIS Technologies	August 19	Dispatchable energy sources	Nuclear fusion	$9.9	N/A	N/A
Hexium	July 24	Dispatchable energy sources	Nuclear fusion	$9.5	N/A	N/A
Vertus Energy	July 2	Clean fuels	Waste to energy/fuel	$9.4	$30.9	Energy Capital Ventures
Metafuels	July 31	Clean fuels	Biofuels	$9.0	$36.9	N/A
Swap Robotics	August 28	Intermittent renewable energy	Solar photovoltaic	$8.9	N/A	N/A

Source: PitchBook • Geography: Global • As of September 30, 2024

Key clean energy early-stage VC deals in Q3 2024

Company	Close date	Segment	Category	Deal value ($M)	Post-money valuation ($M)	Lead investor(s)
*new*cleo	September 30	Dispatchable energy sources	Nuclear fusion	$151.0	N/A	N/A
Sublime Systems	September 11	Clean fuels	Hydrogen	$75.0	N/A	N/A
Peak Energy	July 17	Grid infrastructure	Battery storage	$55.0	N/A	Xora Innovation
Sage Geosystems	September 6	Dispatchable energy sources	Geothermal	$44.8	N/A	Expand Energy
Aether Fuels	September 18	Clean fuels	Waste to energy/fuel	$36.9	N/A	AP Ventures
Solarcycle	August 1	Intermittent renewable energy	Solar photovoltaic	$31.6	N/A	N/A
RedoxBlox	July 3	Grid infrastructure	Nonbattery storage	$29.0	$74.0	N/A
Aalo Atomics	July 19	Dispatchable energy sources	Nuclear fusion	$27.0	N/A	Fifty Years, Valor Equity Partners
Sunswap	August 26	Intermittent renewable energy	Solar photovoltaic	$22.3	N/A	BGF
BSLBATT	July 9	Grid infrastructure	Battery storage	$21.0	$371.0	N/A

Source: PitchBook • Geography: Global • As of September 30, 2024

Key clean energy late-stage VC deals in Q3 2024

Company	Close date	Segment	Category	Deal value ($M)	Post-money valuation ($M)	Lead investor(s)
Mobii Green Energy	September 29	Clean fuels	Hydrogen	$2,000.0	N/A	N/A
China Hydrogen Energy Technology	August 8	Clean fuels	Hydrogen	$1,000.0	N/A	N/A
Zenergy	July 24	Grid infrastructure	Battery storage	$137.7	$2,506.2	N/A
Zap Energy	July 30	Dispatchable energy sources	Nuclear fusion	$130.0	$1,100.0	Soros Fund Management
Kyoto Fusioneering	July 23	Dispatchable energy sources	Nuclear fusion	$82.4	$329.6	JIC Venture Growth Investments
Hydrogenious LOHC Technologies	September 12	Clean fuels	Hydrogen	$80.3	N/A	N/A
Xurya	July 1	Intermittent renewable energy	Solar photovoltaic	$75.0	$119.3	Norfund
Marvel Fusion	September 25	Dispatchable energy sources	Nuclear fusion	$69.7	N/A	HV Capital
PowerX	September 11	Grid infrastructure	Battery storage	$65.4	N/A	N/A
LevelTen Energy	July 16	Grid infrastructure	Analytics & grid management	$65.0	$280.0	B Capital Group

Source: PitchBook • Geography: Global • As of September 30, 2024

Key clean energy venture growth deals in Q3 2024

Company	Close date	Segment	Category	Deal value ($M)	Post-money valuation ($M)	Lead investor(s)
Twelve	September 19	Clean fuels	Clean conventional fuels	$245.0	N/A	Capricorn Investment Group, Fortescue Future Industries, Pulse Fund, TPG
24M	September 5	Grid infrastructure	Battery storage	$87.0	$1,300.0	Nuovo+
Beam	July 3	Intermittent renewable energy	Wind	$38.9	N/A	N/A
Terrestrial Energy	July 17	Dispatchable energy sources	Nuclear fusion	$29.3	N/A	N/A
MetOx International	September 23	Grid infrastructure	Analytics & grid management	$25.0	N/A	Centaurus Capital, New System Ventures
General Fusion	July 16	Dispatchable energy sources	Nuclear fusion	$22.7	N/A	BDC Capital, Canadian Nuclear Laboratories
Standard Energy	July 8	Grid infrastructure	Battery storage	$18.1	N/A	LB Investment
Electrochaea	August 26	Clean fuels	Clean conventional fuels	$16.4	N/A	N/A
Eneida.io	July 5	Grid infrastructure	Analytics & grid management	$11.3	N/A	Junction Growth Investors, Santander Asset Management
GlassPoint	July 2	Intermittent renewable energy	Solar thermal	$10.5	N/A	300PPM

Source: PitchBook • Geography: Global • As of September 30, 2024

Top strategic acquirers of clean energy companies since 2017

Acquirer	Deal count	Investor type
Shell	6	Corporation
Generac Power Systems	3	Corporation
Schneider Electric	3	Corporation
Enphase Energy	2	Corporation
KrakenFlex	2	Corporation
Arcadia Power	2	PE-backed company
Sensata Technologies	2	Corporation
Reliance Industries	2	Corporation
Chart Industries	2	Corporation
BorgWarner	2	Corporation

Source: PitchBook • Geography: Global • As of September 30, 2024
Note: List excludes some companies tied at two deals.

Top VC investors in clean energy companies since 2017

Company	Total deal count	Pre-seed/ seed	Early-stage VC	Late-stage VC	Venture growth	Investor type
Climate Capital	47	24	15	8	0	VC
Energy Impact Partners	29	3	10	12	4	VC
Lowercarbon Capital	25	6	10	9	0	VC
Equinor Ventures	23	2	6	10	5	CVC
Shell Ventures	21	1	5	12	3	CVC
European Innovation Council Fund	18	0	2	15	1	VC
SOSV	18	14	3	1	0	VC
High-Tech Gründerfonds	17	7	6	3	1	VC
HAX	16	12	3	1	0	VC
Prelude Ventures	16	0	10	5	1	VC

Source: PitchBook • Geography: Global • As of September 30, 2024

Top VC-backed clean energy companies by total VC raised to date

Company	VC ($M) raised to date	Segment	Category	IPO probability	M&A probability	No exit probability	Success probability
Northvolt	$6,867.5	Grid infrastructure	Battery storage	93%	5%	2%	98%
CGN Wind Energy	$4,771.0	Intermittent renewable energy	Wind	N/A	N/A	N/A	N/A
Start Campus	$4,157.1	Grid infrastructure	Analytics & grid management	N/A	N/A	N/A	N/A
SVOLT	$3,231.3	Grid infrastructure	Battery storage	N/A	N/A	N/A	N/A
Mobii Green Energy	$2,025.0	Clean fuels	Hydrogen	N/A	N/A	N/A	N/A
Commonwealth Fusion Systems	$1,999.0	Dispatchable energy sources	Nuclear fusion	78%	7%	15%	85%
TAE	$1,314.7	Dispatchable energy sources	Nuclear fusion	91%	4%	5%	95%
Sila	$1,308.5	Grid infrastructure	Battery storage	96%	2%	2%	98%
China Hydrogen Energy Technology	$1,000.0	Clean fuels	Hydrogen	N/A	N/A	N/A	N/A
Form Energy	$928.0	Grid infrastructure	Battery storage	97%	1%	2%	98%

Source: PitchBook • Geography: Global • As of September 30, 2024
Note: Probability data is based on PitchBook VC Exit Predictor methodology.

Innovation spotlight

Nuclear fission

Fission technologies are highly varied, and many developers are currently focusing on demonstration projects.

Nuclear fission

Whilst Q3 2024 has seen growth in VC deal activity for nuclear fusion technologies, another source of nuclear power generation—nuclear fission—remains far more mature and represents the only option currently available for generating usable energy from nuclear activity. Working fission reactors have been in use since the mid-20th century, and some relatively early designs are still operational. Overall, the space has seen $313.2 million in VC deal value YTD as of Q3 2024 (compared to $467.2 million across 2023) with the largest deal of 2024 being *new*cleo's $151 million Series A.

Recently, US interest in reopening decommissioned nuclear power plants has grown, including:

- The Palisades Nuclear Generating Station, a pressurized water reactor in Michigan. However, recent challenges have arisen through underestimation of corrosion in the facility's steam generators.[6]

- Unit 1 at the Three Mile Island Nuclear Generating Station in Pennsylvania, the unit next to Unit 2, which has been out of use since its reactor experienced a partial meltdown during the 1979 Three Mile Island accident.

Beyond renewed operations of older facilities, startups are developing novel fission technologies that aim to address key challenges faced by conventional nuclear fission technologies, including high costs, permitting issues, and long deployment times. Two developments are driving much of the innovation in nuclear fission technology:

- **Advanced reactor designs:** Though specific definitions of fission reactor generations are not globally accepted, contemporary reactor designs are generally considered "Generation III" or "Generation III+," whilst many of the older operational nuclear power facilities use Generation II reactors—the first designs focused on generating power on a commercial scale, built from the mid-1960s to the mid-1990s. Generation III and Generation III+ reactors are generally considered evolutions of earlier reactors, utilizing advancements in fuel technologies, efficiency, safety, and construction. Several startups are developing Generation IV reactors, many of which represent a more substantial departure from existing reactor technologies, as they utilize novel fuels and coolants or other improvements from conventional reactor design. Depending on the design specifics, these reactors may have efficiency benefits, improved coproduction of process heat, lower volumes of problematic waste, or the ability to reuse waste fuel from other reactors.

- **Small modular reactors:** Reducing the size and output of reactors offers some benefits that are particularly relevant given the challenges around planning and installing nuclear energy generation, potentially increasing the number of applications that these reactors can be used for whilst still allowing larger installations through use of multiple reactors. Smaller, modular designs could streamline hardware manufacturing and shorten construction times.

6: "Corrosion Exceeds Estimates at Michigan Nuclear Plant US Wants to Restart, Regulator Says," Reuters, Timothy Gardner, October 2, 2024.

Economic benefits of SMRs

SMR designs offer theoretical cost reductions relative to conventional larger-scale reactors via a number of factors, including the design simplification that comes with standardizing reactor designs compared with bespoke projects, allowing iterative improvements as data emerges from the deployed technology. Familiar reactor designs are also a benefit for regulators, allowing more standardized regulatory requirements, and this further benefits project managers by increasing the predictability of regulatory requirements, using precedents set by previous SMR projects that utilize the same reactors. Lower financing costs are also a potential benefit of SMRs relative to conventional reactors—with more predictable, lower-risk construction shortening installation timelines and reducing risk of cost overruns, thereby reducing risk premiums.

Many of these potential economic benefits of advanced reactors and SMR designs are not yet realized, with most VC-backed companies in the space not yet at the stage of installing commercial reactors, instead focusing on developing technology, constructing demonstrations, or other first-of-a-kind (FOAK) projects. X-energy, CORE POWER, and *new*cleo—three of the largest VC-backed nuclear fission companies developing SMR designs—are developing plans to deploy reactors but have not yet completed any installations. These FOAK projects will have different costs than the "Nth-of-a-kind" projects that are planned to come, as hardware construction is not yet standardized, economies of scale are not in place, and regulatory considerations are novel rather than standardized. These FOAK challenges represent a significant hurdle for startups and make it challenging to predict which companies developing nuclear fission technologies will ultimately prove the most successful—many of the technology approaches being developed provide tangible benefits on paper but are reliant on successful scale-up and adoption to see the benefits manifest.

7: "Renewable Power Generation Costs in 2023," International Renewable Energy Agency, September 2024.
8: "Levelized Cost of Energy+," Lazard, June 2024.

Diverse applications

Nuclear fission competes with other forms of low-carbon energy generation, including solar and wind, which have seen falling costs per unit of capacity.[7] Costs vary with the specific installation and conditions, but nuclear energy tends to cost significantly more per unit of capacity than utility-scale solar and wind,[8] though novel designs promising higher efficiency may close the gap somewhat. This cost differential is a challenge for nuclear fission developers, particularly for utility-scale applications, though each energy technology has a unique set of characteristics, including inputs, output variance/stability, speed at which outputs can be changed, and secondary outputs such as process heat. Some specific applications may favor nuclear fission technologies, which tend to produce very stable energy outputs independent of local climate conditions and geography—a trait well suited to certain industrial applications and those with very consistent energy requirements.

Continuous industrial processes such as steelmaking and chemical production are well suited to stable power sources. Whilst intermittent renewable energy coupled with energy storage could be used to fill this need, nuclear technologies that also produce process heat can hold particular value in these applications, where many processes require high temperatures that otherwise rely on additional energy consumption or fossil fuel usage. Clean fuel production—including both hydrogen and drop-in hydrocarbon fuels—are similar in this regard, and in the hydrogen production space in particular, new high-temperature reactor designs allow high-efficiency hydrogen production via thermochemical water splitting, which typically requires temperatures in excess of 750° Celsius (C), with higher efficiency at 1,000° C.[9] Further, high-temperature electrolysis projects like that of Bloom Energy and Xcel Energy could improve efficiencies relative to low-temperature electrolyzers.[10]

9: "Hydrogen Production and Uses," World Nuclear Association, May 17, 2024.
10: "Xcel Energy and Bloom Energy To Produce Zero-Carbon Hydrogen at Nuclear Facility," Bloom Energy, September 19, 2022.

NUCLEAR FISSION

Recent growth in AI and high-performance computing is driving interest in reducing emissions from datacenter usage, and whilst much of this involves energy-efficient cooling technologies, renewable energy, and energy storage, nuclear energy can also be used in this role. Microsoft's recent deal to use energy from the reopened Three Mile Island reactor—currently run by Constellation Energy—provides an example of this, as it is intended to power the company's datacenters for AI use. Other large technology companies are also planning to fuel datacenter expansion partially using nuclear fission, with Amazon and Google both looking to develop nuclear energy generation for this purpose,[11] though more recently Amazon's plans to use existing nuclear energy to power a datacenter were rejected.[12]

Finally, nuclear technologies can provide a means for oil & gas companies to decarbonize their operations—particularly in adverse environments where power grid connection is challenging, such as offshore facilities. Small modular reactors are well suited for these smaller-scale remote operations. In September 2024, engineering company Saipem and SMR developer *new*cleo signed an agreement to study the potential of SMRs to provide low-carbon energy to offshore oil & gas infrastructure.

11: "Amazon, Google Make Dueling Nuclear Investments To Power Data Centers With Clean Energy," AP, Alexa St. John and Jennifer McDermott, October 16, 2024.
12: "189 FERC ¶ 61,078," US Federal Energy Regulatory Commission, November 1, 2024.

Select company highlights

twelve

Overview

Headquartered in California, Twelve develops carbon-utilization technology that creates fuels from captured carbon for use as drop-in replacements for conventional fossil fuels. The company's technology uses an electrolyzer that takes in carbon dioxide and water and produces oxygen and synthesis gas—a combination of carbon monoxide and hydrogen—which can then be converted into various hydrocarbon fuels or used for industrial purposes. This electrolyzer is built using multiple stacked assemblies, allowing it to be scaled to meet varying capacity requirements. The outputs of Twelve's technology are varied, but key use cases include sustainable aviation fuel (SAF)—one of the key applications for low-carbon drop-in fuels considering the challenges decarbonizing air travel/transport through other means such as electrification. Other outputs include industrial chemicals and polymers, which can replace plastics derived from fossil fuels.

In September 2024, Twelve raised $245 million in Series C funding via a combination of equity and debt, which together with additional project equity led by TPG Rise Climate will be used to develop the company's production capabilities.[13] This includes aiding the completion of Twelve's "AirPlant One"—the company's first SAF production facility, which is based in Washington state and is expected to commence production in 2025. Though Twelve's technology is able to produce a range of outputs, it is initially focusing commercial-scale production on SAF.

Key company information

Founded
2015

Post-money valuation
$554.0M

Lead investors
N/A

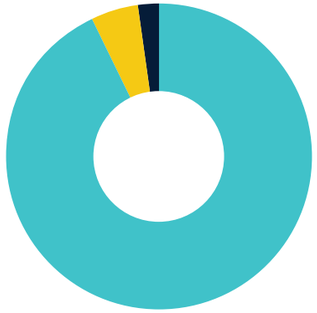
Employees
369

Last financing
Raised $245.0M in a Series C

Total raised
$451.4M over eight deals

First institutional round
$7.0M in seed funding

Exit Predictor



IPO: 93% probability **M&A:** 5% probability **No exit:** 2% probability

Success: 98% probability

Note: Probability data is based on PitchBook VC Exit Predictor methodology.

13: "Twelve Announces $645 Million in Funding Led by TPG to Transform CO2 Into Jet Fuel and E-Chemicals at Scale," Twelve, September 19, 2024.

Leadership

CEO: Nicholas Flanders
CFO: Jimmy Chuang
Chief Technology Officer: Kendra Kuhl, Ph.D.
Chief Scientific Officer: Etosha Cave, Ph.D.
Chief Commercial Officer: Ram Ramprasad, Ph.D.
Chief Productization Officer: David Frank

Competing technologies

Twelve's current focus on SAF production competes with other low-carbon drop-in fuels, including biofuels from dedicated fuel crops and fuels produced from agricultural, industrial, or municipal waste. These technologies typically have lower energy requirements compared with electrofuels, but can face limitations due to their need for available organic matter or waste material streams. Crop-dependent biofuels also suffer some disadvantages in that they compete with food crops for farmland.

Electrofuel technologies also depend on access to clean energy to power their processes, and whilst some companies address this by installing linked clean energy generation, those that plan to purchase clean energy from external sources face competition from a growing number of other sectors looking to decarbonize via use of clean energy, including datacenters, green hydrogen electrolyzers, and green chemical production.

Financing history

Series A	Series AA	Series B	Later-stage VC	Later-stage VC	Series C
February 25, 2021	**July 8, 2021**	**July 1, 2022**	**March 1, 2023**	**June 19, 2024**	**September 19, 2024**
Total raised $28.0M	**Total raised** $29.0M	**Total raised** $130.0M	**Total raised** N/A	**Total raised** $1.0M	**Total raised** $245.0M
Pre-money valuation $80.0M	**Pre-money valuation** $155.0M	**Pre-money valuation** $554.0M	**Pre-money valuation** N/A	**Pre-money valuation** N/A	**Pre-money valuation** N/A
Investors N/A	**Investors** Capricorn Investment Group, Carbon Direct Capital Management	**Investor** DCVC	**Investor** Microsoft Climate Fund	**Investors** N/A	**Investors** TPG, Pulse Fund, Fortescue Future Industries, Capricorn Investment Group

newcleo
Futurable Energy

Overview

Nuclear energy company *new*cleo develops small modular lead-cooled fast reactors alongside developing fuel for these reactors. The company is currently refining reactor designs in addition to the hardware needed to support these reactors. It is also researching challenges, including forms of corrosion specific to reactors using a lead coolant. *new*cleo's first planned reactor will be the LFR-AS-30, a 30 megawatt (MW) reactor designed to validate the company's components and design. It is planned to launch in 2031, ahead of the 2033 launch of AFR-AS-200, a similar but larger 200 MW reactor, and LFR-TL-30, a small 30 MW reactor designed for infrequent refueling and maintenance.[14]

Headquartered in France, *new*cleo has been focusing on development in Europe, and the European Industrial Alliance on Small Modular Reactors recently selected *new*cleo's reactor design for support,[15] which involves working closely with the Alliance's working groups on skills, fuels, research, supply chains, and financing. The company received $151 million in Series A funding in September 2024, whilst also shifting its headquarters from London to Paris.

Key company information

Founded
2021

Post-money valuation
N/A

Lead investors
N/A

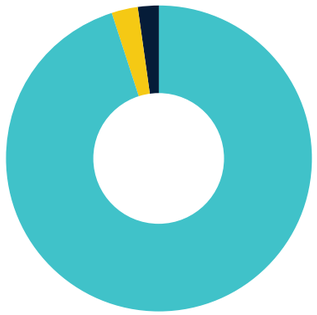
Employees
850

Last financing
Raised $151.1M in a Series A

Total raised
$544.4M over three deals

First institutional round
$138.8M in seed funding

Exit Predictor



IPO: 95% probability **M&A:** 3% probability **No exit:** 2% probability

Success: 98% probability

Note: Probability data is based on PitchBook VC Exit Predictor methodology.

14: "Delivering Our Gen-IV Vision," *new*cleo, n.d., accessed November 12, 2024.
15: "EU Throws Support Behind newcleo Lead Fast Reactor Technology," *new*cleo, October 11, 2024.

Leadership

CEO: Stefano Buono
CFO: Richard Tuffill
COO: Elisabeth Rizzotti
Chief Education and Academic Relations Officer: Massimo Marino
Chief Scientific Officer: Luciano Cinotti
Chief Business Officer: Alberto de Min, Ph.D.
Chief Government and International Affairs Officer: Ruggero Corrias
Chief Information Officer: John Fenwick

Financing history

Seed	Early-stage VC	Series A
August 31, 2021	**June 10, 2022**	**September 30, 2024**
Total raised $138.8M	**Total raised** $318.6M	**Total raised** $151.0M
Pre-money valuation N/A	**Pre-money valuation** $657.4M	**Pre-money valuation** N/A
Investor(s) N/A	**Investor(s)** N/A	**Investor(s)** N/A

Competing technologies

*new*cleo's SMR technologies compete with other SMR designs, which are varied due to the many different Generation IV designs. Looking more broadly at low-carbon energy generation technologies, SMRs compete with renewable energy generation, including solar or wind with attached energy storage to stabilize output volatility. Similarly, more stable clean energy sources such as hydropower and geothermal compete more directly with SMRs and tend to share high upfront costs.

TYPE ONE ENERGY

Overview

Headquartered in Tennessee, Type One Energy Group develops nuclear fusion technologies using a stellarator design.[16] The company is currently developing its first stellarator device as part of an agreement with the Tennessee Valley Authority and the Department of Energy's Oak Ridge National Laboratory. The project's aim is to verify and demonstrate the performance of the company's technology to allow for further refinement. The stellarator design is just one option for fusion technology and serves to improve confinement of the plasma as an alternative design to traditional tokamak designs.

The company raised $82.4 million in seed funding in July 2024—the largest seed round of the quarter. This funding will be used to continue development of Type One Energy Group's technology and demonstration facility.

Key company information

Founded
2019

Post-money valuation
N/A

Lead investors
N/A

Employees
119

Last financing
$82.4M in seed funding

Total raised
$82.4M over two deals

First institutional round
Undisclosed

Exit Predictor

IPO: 64% probability **M&A:** 14% probability **No exit:** 22% probability

Success: 78% probability

16: A stellarator is a variation of the traditional donut-shaped tokamak design, with higher design complexity that adds potential benefits to efficiency.

Note: Probability data is based on PitchBook VC Exit Predictor methodology.

Leadership

CEO: Christofer Mowry
CFO: Charlie Baynes-Reid
Chief Technology Officer: Thomas Pedersen, Ph.D.
COO: Ryan Guerrero
Chief Science Officer: John Canikm, Ph.D.
Chief People Officer: Kairus Tarapore

Competing technologies

Because commercial fusion energy generation is not yet available, it does not currently compete with other energy technologies as far as installed capacity is concerned. However, it is being developed to compete with a range of energy generation technologies, including conventional energy infrastructure such as coal and natural gas power stations in addition to renewable energy technologies and nuclear fission reactors. If successful, nuclear fusion would provide large quantities of clean energy with minimal inputs or waste products. However, the downsides of fusion are strong—it requires high technological complexity, is in its early stages of development, and has high capital requirements for development and project construction.

Financing history

Seed	Seed
April 29, 2024	**July 30, 2024**
Total raised N/A	**Total raised** $82.4M
Post-money valuation N/A	**Post-money valuation** N/A
Investors N/A	**Investors** TDK Ventures, Doral Energy Tech Ventures, Breakthrough Energy

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