THE 2023 EUROPEAN DEEP TECH REPORT

November 2023

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Executive Summary

1. DEEP TECH DEFINED

- Deep Tech is fundamentally new science and engineering making its way into products and companies for the first time
- These technologies have historically unleashed mega-waves of innovations such as the invention of electricity or the transistor
- Deep Tech companies have a different risk profile (e.g., high tech risk, lower market risk) and require a new approach to investing

2. THE EUROPEAN DEEP TECH OPPORTUNITY

- Europe has what it takes to become a global hub for Deep Tech excellence: Strong fundamental research (e.g., 6 schools in top 20 schools globally for computer science), well-educated talent (~1.5x the number of STEM graduates vs. the US), more public support than ever before (e.g., EIC, €1bn NATO fund, SPRIND, JEDI), and positive citizen sentiment (90% of Europeans think that the overall influence of science and tech is positive)

3. FUNDING LANDSCAPE

- *Overall:* Deep Tech is amongst the most resilient VC categories with ~$15bn YTD 2023 (almost on par with 2022 vs. -70% in Fintech)
- *Geographical:* The UK ($3.4bn), France ($3.2bn), and Sweden ($3.2bn) have received most Deep Tech funding across Europe
- *Deep Tech hubs are emerging:* Stockholm ($3.2bn – mega-rounds), London ($1.5bn), Paris ($1.5bn), Grenoble ($1.2bn – mega-rounds), and Munich ($700m)
- *Exits:* The most notable exits were the IPO of ARM (~$54bn) and acquisition of InstaDeep by BioNTech (~$562m)

Executive Summary

4. SEGMENT DEEP DIVES

NOVEL AI

+50% vs. 2022, record year $1.3bn in funding (1.5x 2021)

GenAI model makers
Aleph Alpha €110m Series B, Mistral $113m Seed

Autonomous driving
Conigital $400m Series A, Oxa $140m Series C

FUTURE OF COMPUTE

+10% vs. 2022 ($1.1bn vs. $900m)

AR/VR
Aledia €120m Series D

Quantum Pasqal €100m Series B

SPACE TECH

+5% vs. 2022 ($784m vs $737m)

Launch
Isar Aerospace $165m Series C

Transportation
Exotrail $58m Series C

NOVEL ENERGY

-50% vs. 2022 ($656m vs. $1.3bn)

Supercapacitors
Skeleton Tech €104m

COMPUTATIONAL BIOLOGY & CHEMISTRY

-50% vs. 2022 ($288m vs. $505m)

Life Science R&D
Causaly $60m Series C

AI-drug discovery
Chemify £36m Series A

5. CHALLENGES & RECOMMENDATIONS

- Some of the biggest challenges that remain in Europe are to encourage more entrepreneurs to move into Deep Tech, to harmonise university spinout terms, to form more dense talent / excellence clusters, to increase the LP base and involvement of institutional investors, to stress the importance of governments & corporations as customers, to strengthen the exit channels, and to promote diversity across founders & investors
- These challenges can only be tackled if Europe acts united and embraces coopetition

About this report

The term Deep Tech invokes great excitement for some, scepticism for others, and sometimes both simultaneously.

Great excitement has been generated by quantum computing, the first glimpse of an artificial general intelligence, or new protein design solutions. Artificial Intelligence alone could add another $13 trillion to the global economy over the next decade, according to McKinsey & Company. The potential value of nuclear fusion or curing cancer is hard to overstate.

Meanwhile, there's also scepticism, not about these innovations, but about the term 'Deep Tech'. Firstly, it's rather vague. Secondly, it implies a too narrow focus on cool technologies for their own sake, while losing sight of commercialisation & competitiveness.

The EU is heavily investing in strengthening Europe's Deep Tech ecosystem. But there is a worry that this effort is insufficiently supported by efforts to make Europe more competitive and entrepreneurial.

This report aims to better establish what Deep Tech actually is, how Europe's ecosystem works, what it's lacking, how it can compete and what desirable policy goals might be.

LAKE STAR (W)^C Walden Catalyst dealroom.co

Methodology

Deep Tech is constantly evolving

Some technologies that were once considered deep have now become mainstream and widely adopted. LLMs are going through this transition currently. This is why certain companies are included in previous reports but not in this year's report.

As a result, funding numbers may vary from year to year.

Data cut-off dates

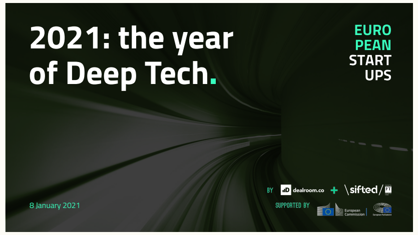
The report is released before the end of 2023.

As a result, funding numbers have been extrapolated from 1 November 2023, to the end of the year 2023.

Data sources

Dealroom is the primary data provider for this report. References to additional data sources and reports can be found on each slide.

Previous editions of the Deep Tech Report



2021

2022

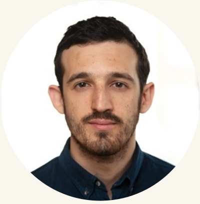
About the authors

Steven Jacobs
Lakestar

Christina Franzeskides
Lakestar

Lukas Leitner
Lakestar

Nicolas Autret
Walden Catalyst



Lorenzo Chiavarini
Dealroom

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Thank you to all contributors for their valued insight:

Alex Pasteur, F-Prime

Cyril Vancura, imec.xpand

Daniel Metzler, Isar Aerospace

Emma Schepers, Verve Ventures

Emmanuelle Martiano Rolland, Aqemia

Eric Leupold, Deutsche Börse

Ferdinando Sigona, LocalGlobe

Gianluigi Baldesi, ESA

Herbert Mangesius, Vsquared

Hermann Hauser, ARM & Amadeus Capital

Jonas Andrulis, Aleph Alpha

Klaus Hommels, Lakestar

Lilian Schiwch, cylib

Mark Boggett, Seraphim

Markus Pflitsch, Terra Quantum

Maximilien Levesque, Aqemia

Moritz von der Linden, Marvel Fusion

Rasmus Rothe, Merantix

Roger Havenith, EIF

Susanne Schorsch, Amadeus Capital

Théau Peronnin, Alice & Bob

Young Sohn, Walden Catalyst

About the authors

European, multi-stage venture capital firm

Lakestar invests with a long-term view across all stages from Seed to Growth. We care about Europe. We understand its regulations and politics. We speak the languages and appreciate its cultures. Yet we have a global mindset and like to build bridges between continents, through our deep relationships in many different ecosystems.

Lakestar's Deep Tech team focuses on novel scientific and engineering breakthroughs that are making their way into companies and products for the first time. We live on the bleeding edge and are constantly looking for contrarian views on how the world is going to change for the better.

Global venture capital firm dedicated to Deep Tech investments

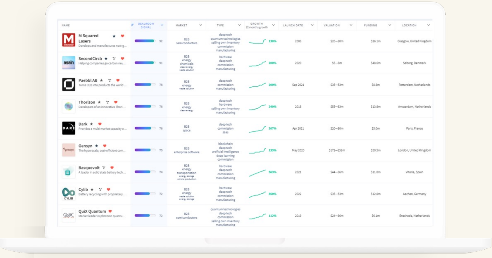
Walden Catalyst Ventures is helping early-stage companies in the US, Europe, and Israel build the next generation of category-defining businesses in Deep Tech. We back the bold and the daring—trailblazers who are changing the world and making life better for all of us.

Walden Catalyst invests in innovators and entrepreneurs passionate about disruptive technologies and committed to excellence. For startups, this translates into unparalleled access to operational expertise, global reach, and a network of industry captains eager to help build and scale the companies of the future.

Global startup & venture capital intelligence platform

Dealroom.co is a global intelligence platform for discovering and tracking the most promising companies, technologies and ecosystems. Clients include many of the world's foremost organisations such as Sequoia, Accel, Index Ventures, McKinsey, BCG, Deloitte, Google, AWS, Microsoft, Stripe.

Dealroom partners closely with local tech ecosystem development agencies and enablers, to create a comprehensive multi-dimensional blueprint of the tech ecosystem, including capital, talent, innovation, entrepreneurship and overall economic dynamism.



Content

1.
DEEP TECH DEFINED

We define Deep Tech as

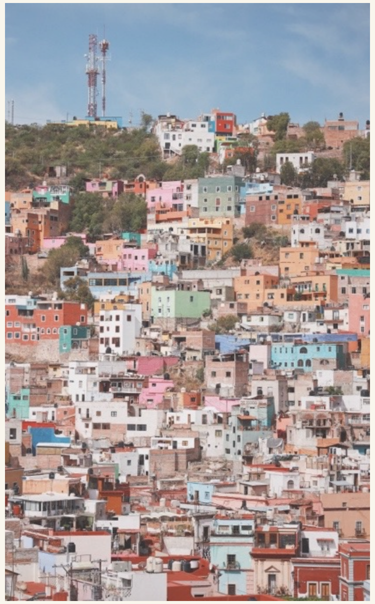
novel scientific or engineering breakthroughs

making their way into
products and companies
for the first time

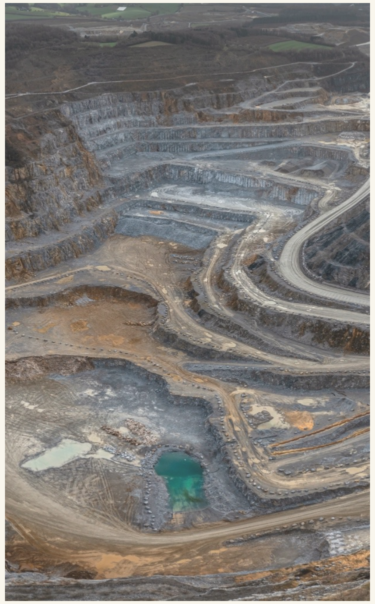
Today's global problems require fundamentally new scientific & engineering breakthroughs to solve them

Deep Tech is instrumental to tackling today's biggest challenges, from climate change and food security to intractable disease.

POVERTY & INEQUALITY

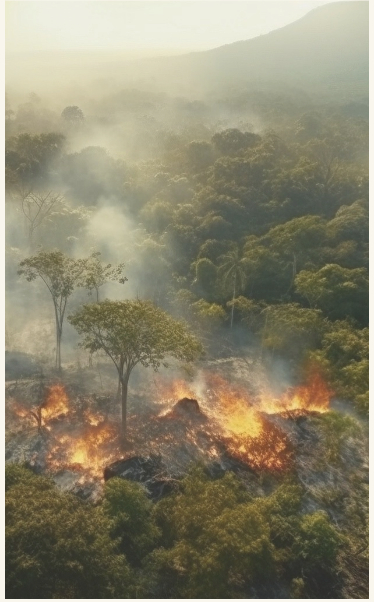


RESOURCE SCARCITY

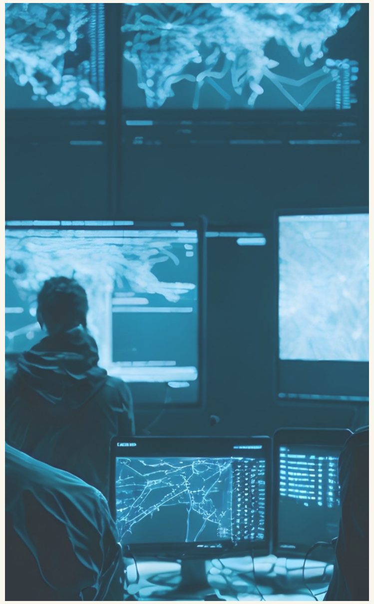


PHYSICAL & MENTAL HEALTH

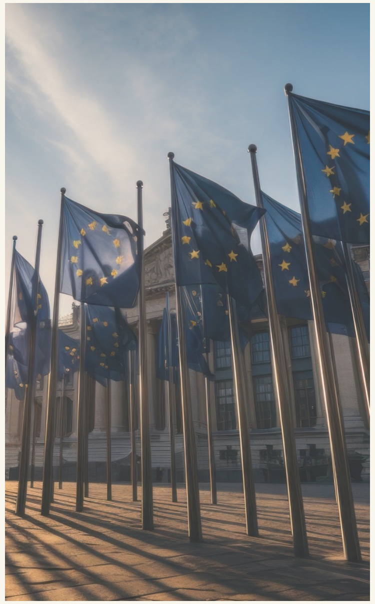
CLIMATE CHANGE



PRIVACY & CYBERSECURITY



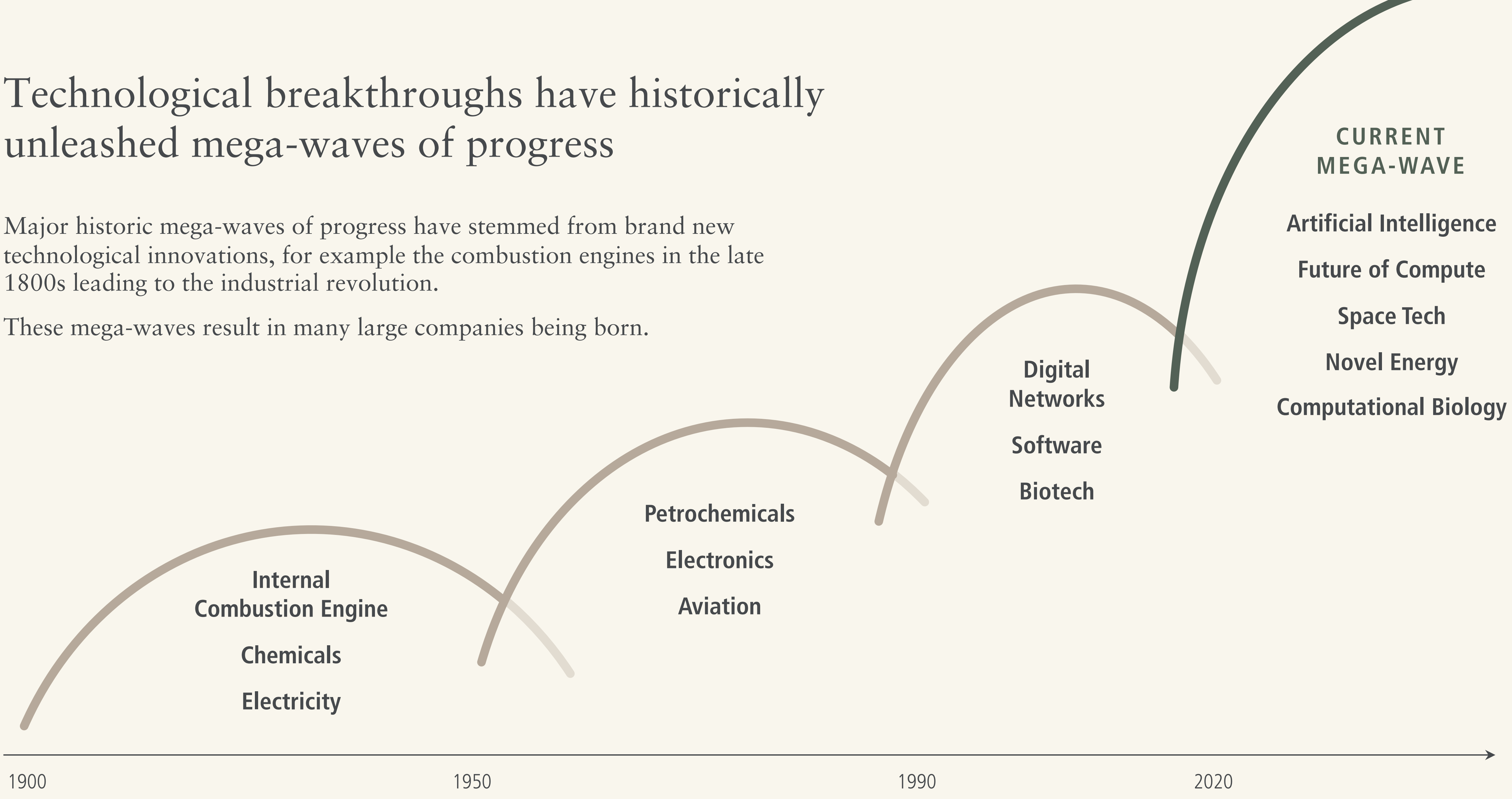
FREEDOM & SOVEREIGNTY



Technological breakthroughs have historically unleashed mega-waves of progress

Major historic mega-waves of progress have stemmed from brand new technological innovations, for example the combustion engines in the late 1800s leading to the industrial revolution.

These mega-waves result in many large companies being born.



LAKE STAR (W)C Walden Catalyst dealroom.co

These mega-waves have created some of today's most valuable companies and will form the cornerstone of tomorrow's

Deep Tech can be found in the heart of the most valuable companies and industries – from the telephone, the internet, cars, electricity to aircrafts.

Almost everything used in today's world has its roots in Deep Tech, however these 'deep' technologies often turn into 'traditional' technologies over time as they become more widespread.

Mercedes-Benz invented the first automobile in the late 19th century

Mercedes-Benz

Apple pioneered the first PC in the 1970s

Google developed the first novel algorithms in the 1990s that formed Google Search

Google

BioNTech developed the first mRNA vaccines for COVID-19 in 2020

BIONTECH

LAKE STAR

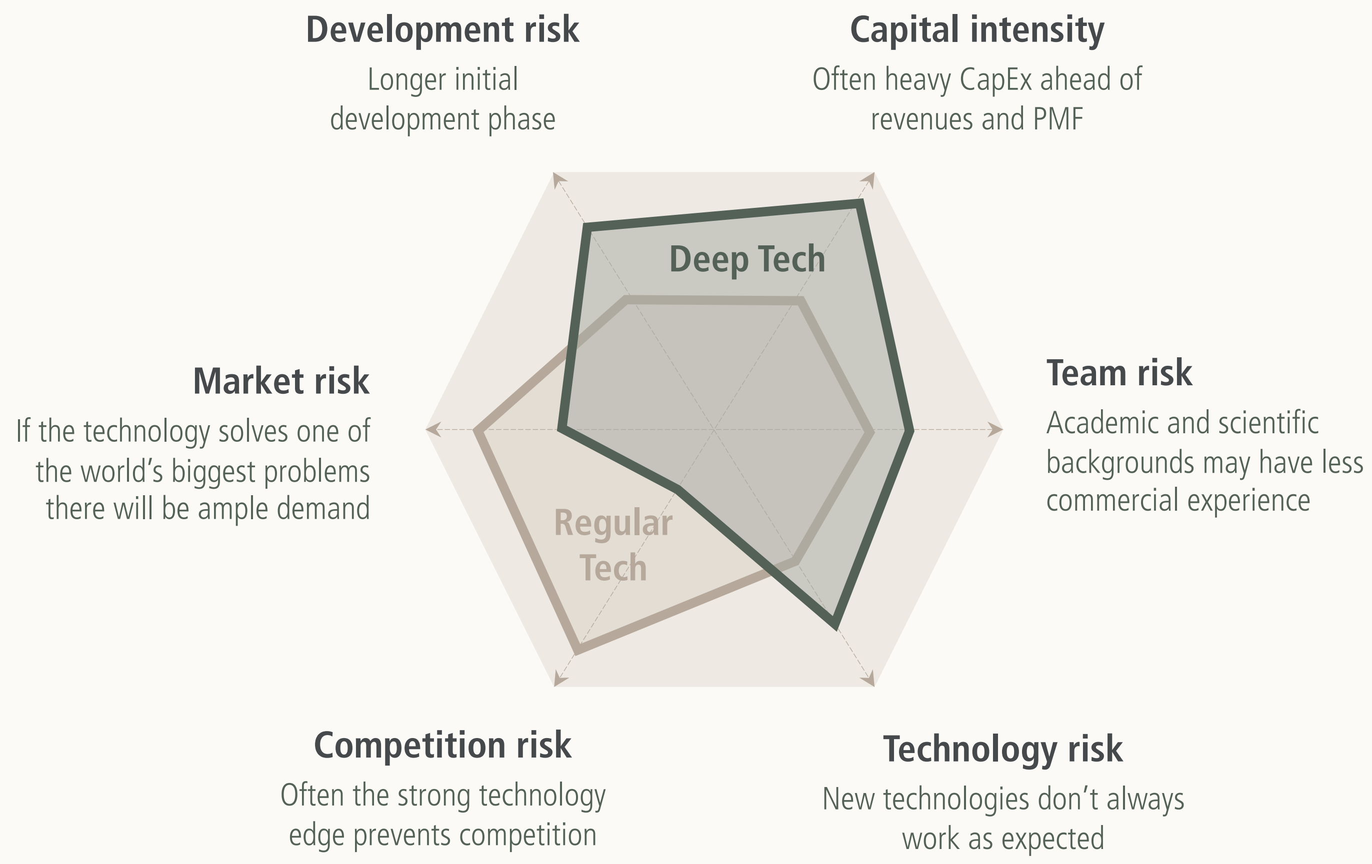
(W)C Walden Catalyst

dealroom.co

Deep Tech startups have a different risk profile compared to traditional startups

Technology risk is higher, CapEx intensity is often greater and development times are much longer.

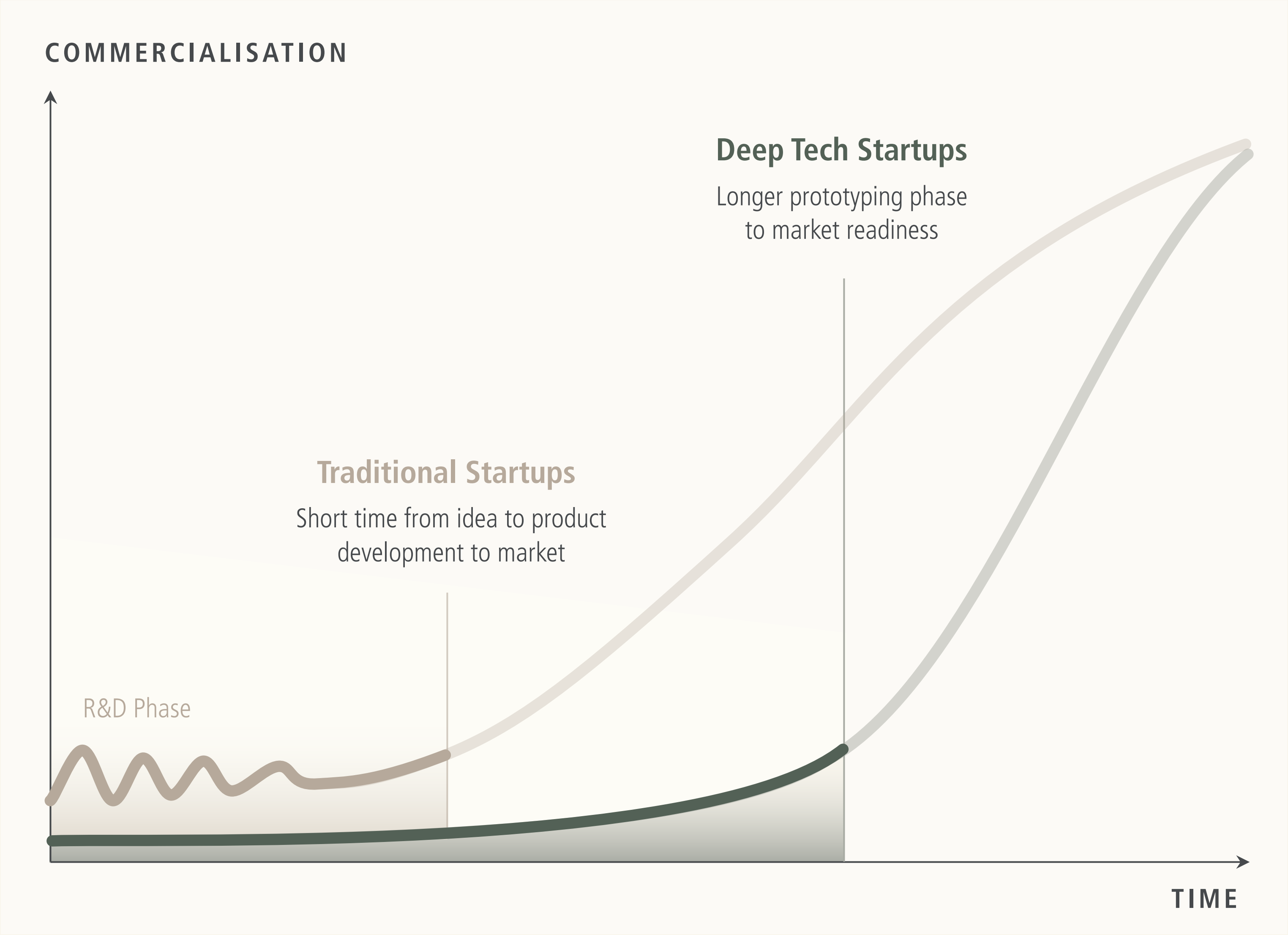
Unlike regular startups, Deep Tech companies have a stronger defensibility moat towards competition thanks to their cutting-edge technologies at their core, IP portfolio and teams of technical expertise.



LAKE STAR
(W)C Walden Catalyst
dealroom.co

Development times are longer

Deep Tech startups have a longer initial Research & Development phase compared to traditional startups, so the time required to go from idea to market is often longer.

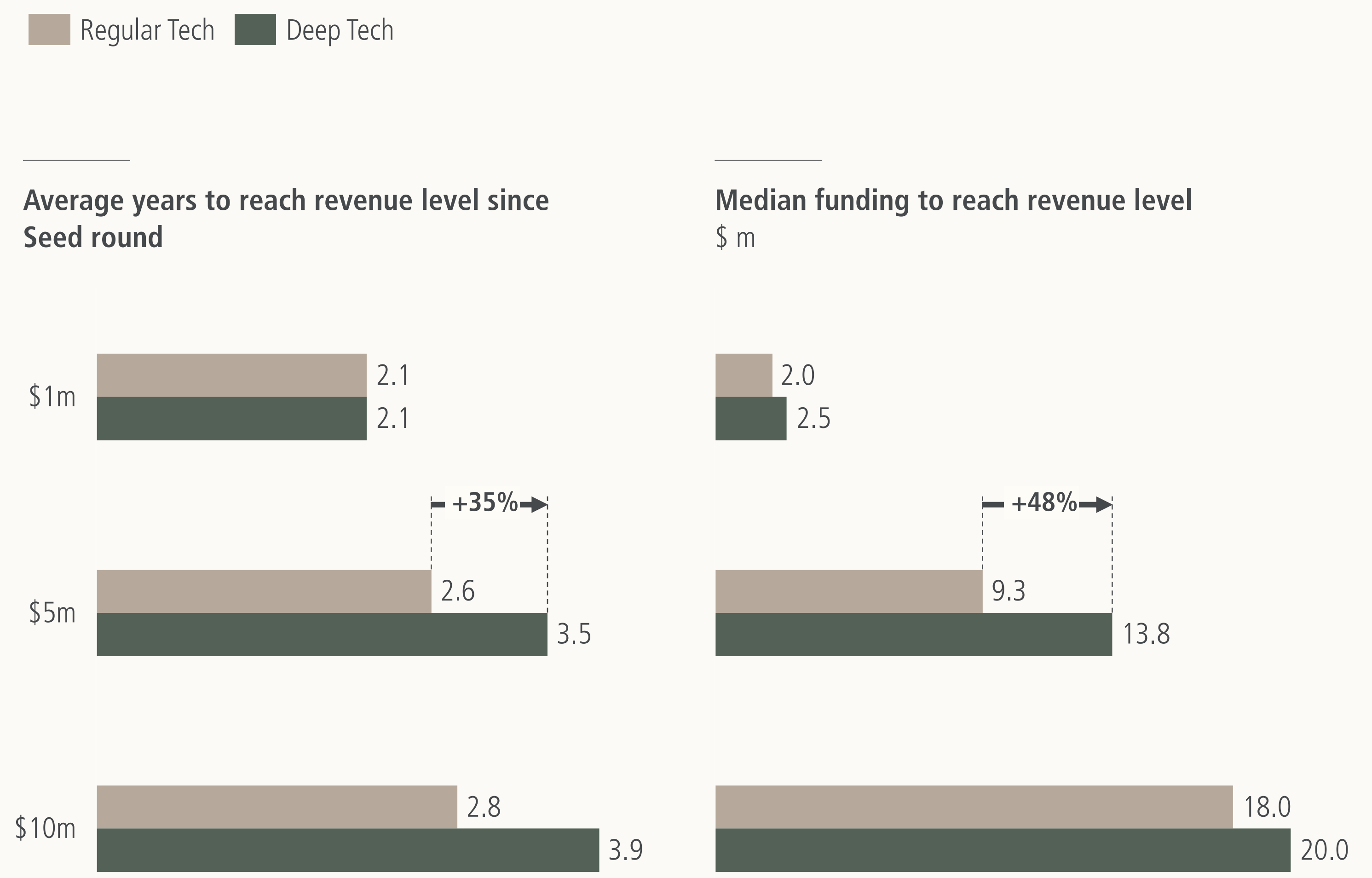


LAKE STAR | Walden Catalyst | dealroom.co

Capital intensity is greater

Deep Tech startups take at least 35% more time and 48% more capital than traditional startups to reach revenue levels of $5m+, resulting in more capital required to reach product-market fit and more dilution for founders and investors.

Surprisingly, however, they actually take around the same amount of time (approx. 2 years) to reach revenues of $1m, and only 11% more capital to reach $10m revenue, suggesting that this discrepancy may narrow over time.



LAKE STAR

(W)C Walden Catalyst

dealroom.co

Given the different risk profile, Deep Tech requires a new approach to investing

Investors need to understand how to assess and perform diligence on the higher technology and team risks.

Team risk is higher

The biggest challenge for Deep Tech founding teams is to complement their technical abilities with business acumen and a commercial mindset.

Technology risk is higher

Building breakthrough, novel technologies has inherently higher risk than using well established technology.
The advantage to building new technology is that it creates a lot of value and defensibility.

Competition risk is lower

Due to their strong technological edge Deep Tech startups have a defensible moat against competitors. For example, quantum startups are difficult to build and require talent that is scarce. This compares to traditional startups which rely on network effect and market dominance as their main competitive edge.

Market risk is lower

Deep Tech startups rarely have comparable products in the market primarily because they're solving a large problem in a brand-new way. Their underlying breakthrough technology unlocks huge market opportunities and often creates entirely new markets. Regardless, both Deep Tech and traditional startups require product-market fit to succeed, and Deep Tech startups must avoid the trap of becoming a 'technology looking for a problem'.

Deep Tech is far-reaching and spans many industries and verticals

NOVEL AI
Autonomous driving, explainable AI, privacy-enhancing technologies, etc.

FUTURE OF COMPUTE
Superconductors, quantum, ambient computing, brain-computer interface, etc.

SPACE TECH
Launch, earth observation, in-space manufacturing, etc.

NOVEL ENERGY
Hydrogen, fusion, new battery chemistries, etc.

COMPUTATIONAL BIOLOGY & CHEMISTRY
AI-enabled drug discovery, protein design, biofuels, etc.

ADVANCED MATERIALS
Green concrete, graphene, etc.

ROBOTICS & DRONES
Humanoid robots, nanorobotics, drones, etc.

OTHER
Cybersecurity, synthetic biology, lab grown food, etc.

NOT IN FOCUS IN THIS DOCUMENT

Successful VC-backed companies can be found across each Deep Tech sub-category

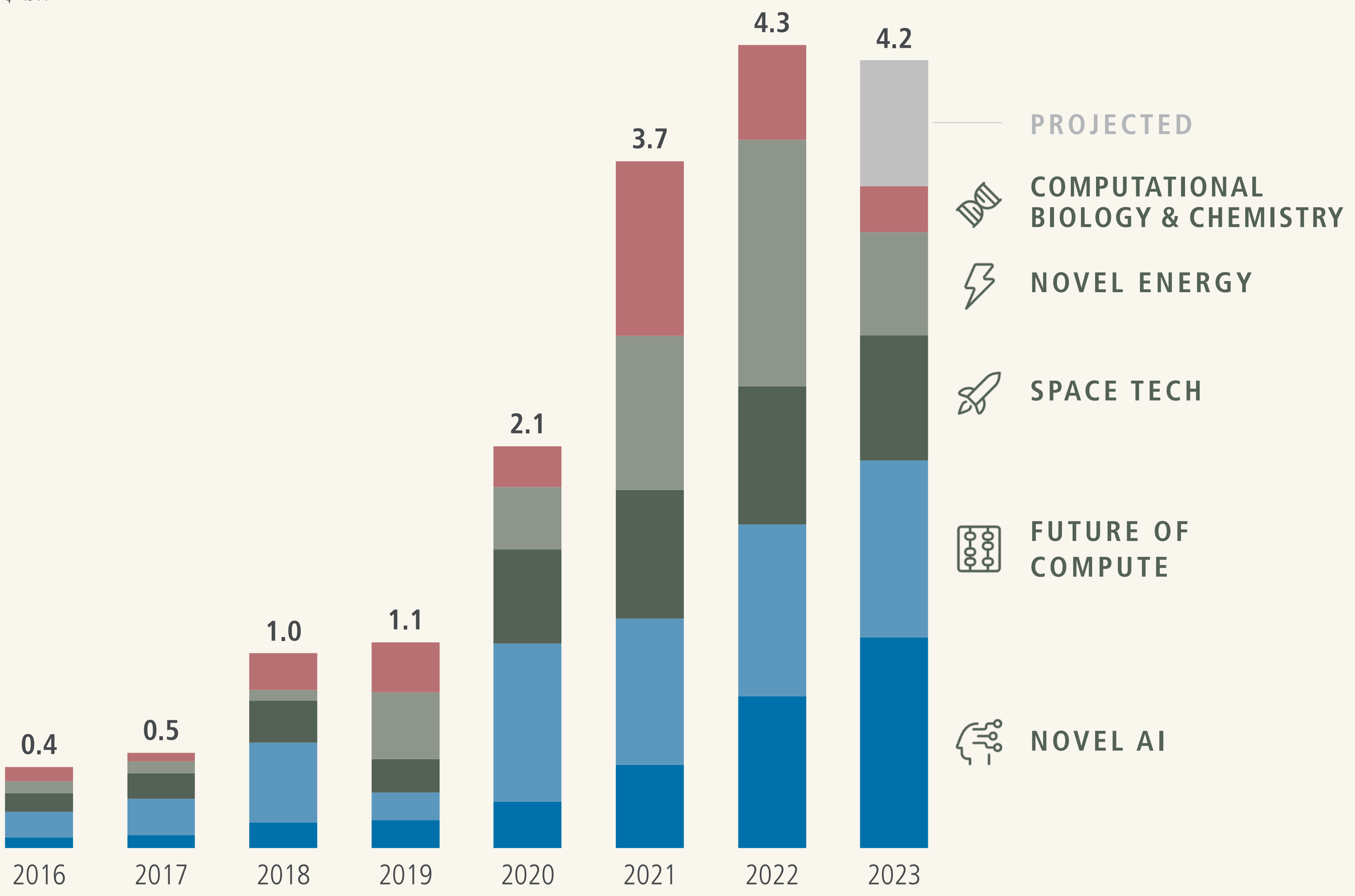
	NOVEL AI	FUTURE OF COMPUTE	SPACE TECH	NOVEL ENERGY	COMPUTATIONAL BIOLOGY & CHEMISTRY	ADVANCED MATERIALS	ROBOTICS & DRONES	OTHER
BIGGEST SUCCESSES	DeepMind General purpose AI	IQM Quantum computers	OneWeb Connectivity satellites	newcleo Nuclear fission	Exscientia AI-drug discovery	OCSiAl Graphene nanotubes production	CMR Surgical Surgical robotics	Darktrace AI-enhanced cybersecurity
	Aleph Alpha GenAI model maker	Terra Quantum Quantum algorithms	isar aerospace Launch vehicles	Tokamak Energy Nuclear fusion	CRISPR Therapeutics Gene-based medicine dev.	avantium Green chemicals	Agile Robots Intelligent robotics	Mosa Meat Lab-grown meat
	Mistral AI_ GenAI model maker	WaveOptics AR hardware	ICEYE Earth Observation satellites	Skeleton Technologies Supercapacitors	causaly AI solutions for life sciences R&D	Carbios Bioplastic	Exotec Robotics for warehouse automation	DNA Script DNA synthesis
	Conigital Connected Digital Autonomous driving	Smart Photonics Photonic Integrated Circuits	EnduroSat Satellite Manufacturing	sunfire Fuel cells	OMass Therapeutics Drug discovery mass spectrometry platform	Notpla Bioplastic	wandelbots Robot programming	H2 green steel Green Steel
RISING STARS	FLock.io Federated learning	gensyn Distributed computing	clearspace today Space debris removal	nyobolt Ultra-fast charging batteries	Peptone AI-drug discovery	again Carbon utilisation for chemicals	outsight Lidar for robotics	EXEIN IoT embedded cybersecurity
	ZAMA Fully homomorphic encryption	QuiX Quantum Photonic quantum computing	The Exploration Company Space exploration	Proxima Fusion Nuclear fusion	Chemify AI-drug discovery	traceless Bioplastic	ANYbotics Robotics for industrial inspection	Solar Foods Precision fermentation
	UnlikelyAI Explainable AI	Alice & Bob Quantum computers	Atlant 3D Nanosystems In-space manufacturing	BasqueVolt Solid-state battery	Aqemia AI and quantum drug discovery	mogu Mycelium-based materials	Wingcopter Commercial drones	Core Biogenesis Synthetic biology x pharma
	Apheris Federated learning	Axelera AI In-memory computing	constellr Satellite imagery	Cylib Battery recycling	Qubit Pharmaceuticals Quantum drug discovery	Paebbl Carbon capture x cement	Moon Surgical Surgical robotics	ascendance Urban air mobility (eVTOL)

NOT IN FOCUS IN THIS DOCUMENT (Advanced Materials, Robotics & Drones, Other)

In this report, we focus our attention on some of the fastest growing Deep Tech areas

VC investment in European emerging Deep Tech startups

$ bn



LAKE STAR

(W)C Walden Catalyst

dealroom.co

2.
THE EUROPEAN DEEP TECH OPPORTUNITY

Many European Deep Tech successes have their roots in academia

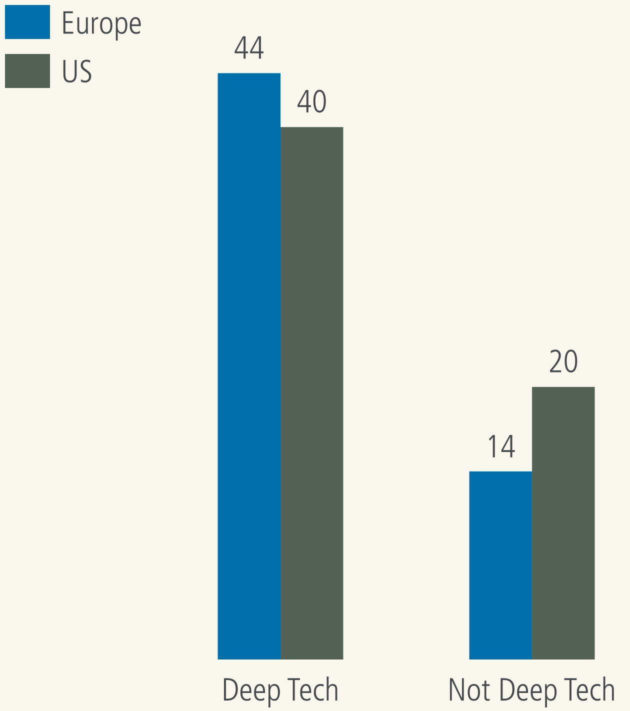
Some of the most valuable companies in Europe have spun out from academia…

Valuable European Deep Tech spinouts (examples)

Company	Category	University	Valuation	VC funding
BIONTECH	Biotech	Johannes Gutenberg University Mainz	$23bn	$1.4bn
climeworks	CO_2 capture	ETH Zurich	$2.2–3.3bn	$777m
DARKTRACE	Cybersecurity	Cambridge	$2.2bn	$230m
Oxford NANOPORE Technologies	AI Biotech	Oxford	$2.1bn	$1.3bn
mindmaze	VR health	EPFL	$1.5bn	$339m
SENSIRION	Smart sensors	ETH Zurich	$1.4bn	-
AGILE ROBOTS	Robotics	German Aerospace Center (DLR)	$1.0bn	$260m

…and most Deep Tech startups in Europe and the US have patents at their core

% startups with patents >$5m funding



Strong European universities and research institutes fostered these success stories

Europe's *universities* are 30% of top Computer Science institutions globally, with UK and Switzerland at the top

THE World University Rankings 2024 by subject: Computer Science

1. University of Oxford	11. National University of Singapore
2. Stanford University	12. Tsinghua University
3. Massachusetts Institute of Technology (MIT)	13. California Institute of Technology
4. Carnegie Mellon University	14. Cornell University
5. ETH Zurich	**15. Technical University of Munich (TUM)**
6. Harvard University	16. Peking University
7. University of Cambridge	**17. École Polytechnique Fédérale de Lausanne (EPFL)**
8. Imperial College London	18. University of Washington
9. Princeton University	19. University of Illinois at Urbana-Champaign
10. University of California, Berkeley	20. Nanyang Technological University, Singapore

THE World University Rankings 2024 by subject: Engineering

1. Harvard University	**11. ETH Zurich**
2. Stanford University	12. Georgia Institute of Technology
3. Massachusetts Institute of Technology (MIT)	13. Nanyang Technological University, Singapore
4. University of Oxford	14. Peking University
5. University of Cambridge	15. Tsinghua University
6. University of California, Berkeley	**16. Delft University of Technology**
7. California Institute of Technology	17. University of California, Los Angeles
8. Princeton University	18. Yale University
9. National University of Singapore	19. University of Michigan-Ann Arbor
10. Imperial College London	**20. École Polytechnique Fédérale de Lausanne (EPFL)**

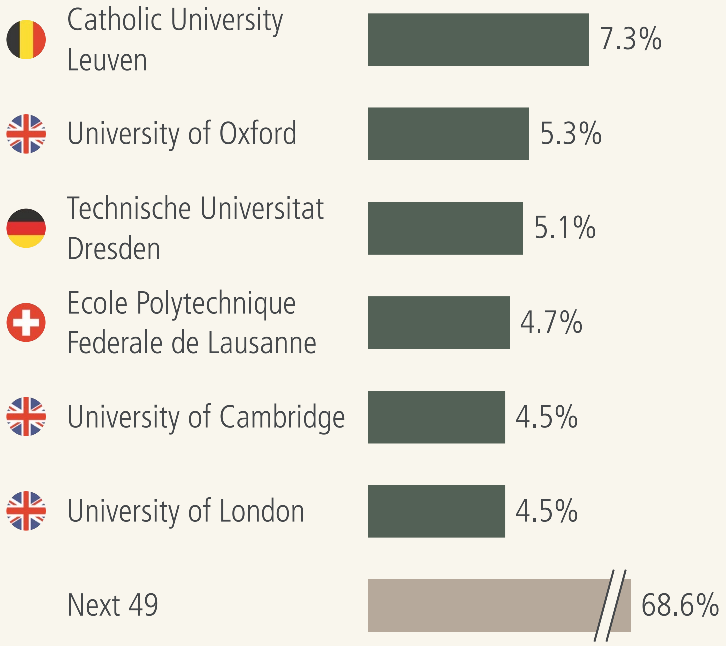
Europe is home to 40% of the top 10 world-class *research institutes;* Germany and France most prominent due to greater public funding

Rank	Institute	Country	Size	Visibility	Rich Files	Scholar
1	National Institutes of Health	US	1	2	2	6
2	National Aeronautics and Space Administration	US	7	3	19	18
3	**Centre National de la Recherche Scientifique CNRS**	France	**23**	**31**	**93**	**2**
4	**Max Planck Gesellschaft**	Germany	**45**	**21**	**3**	**4**
5	Chinese Academy of Sciences CAS 中国科学院	China	32	25	593	1
6	Centers for Disease Control and Prevention	US	73	4	28	42
7	US Department of Veterans Affairs	US	53	15	56	7
8	**Consejo Superior de Investigaciones Cientificas CSIC**	Spain	**26**	**60**	**11**	**6**
9	National Oceanic and Atmospheric Administration	US	30	6	22	68
10	**Consiglio Nazionale delle Ricerche CNR**	Italy	**22**	**56**	**15**	**9**
11	Lawrence Berkeley National Laboratory	US	37	26	5	21
12	Smithsonian Institution	US	14	11	31	71
13	US Geological Survey	US	25	12	32	66
14	National Institute of Standards and Technology	US	42	14	21	83
15	Commonwealth Scientific and Industrial Research Organization	Australia	20	32	16	27
16	**Karlsruher Institut für Technologie**	Germany	**15**	**38**	**24**	**35**
17	US Environmental Protection Agency	US	19	8	83	151
18	**Intitut National de Recherche en Informatique et en Automatique**	France	**31**	**43**	**36**	**50**
19	**Intitut National de la Santé et de la Recherche Médicale**	France	**108**	**175**	**13**	**8**
20	Argonne National Laboratory	US	162	54	18	48
21	Oak Ridge National Laboratory	US	240	46	23	54
22	**Fraunhofer Gesellschaft**	Germany	**90**	**28**	**87**	**67**
23	**Istituto Nazionale di Fisica Nucleare**	Italy	**62**	**121**	**1**	**40**
24	University of Texas M.D. Anderson Cancer Center	US	518	111	4	24
25	Sloan Kettering Memorial Cancer Center	US	368	107	6	26

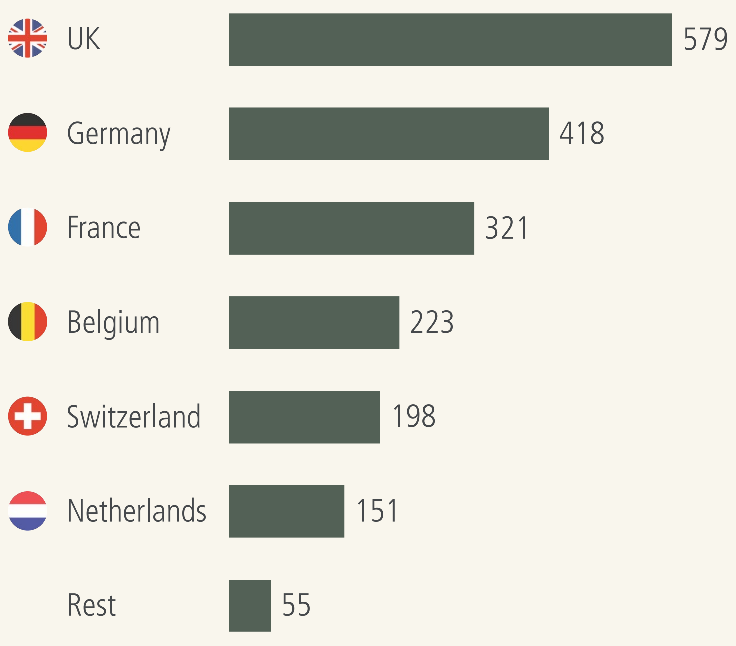
Source: Dealroom.co; webometrics.info

Within Europe, UK institutions show the highest Deep Tech patent activity – However, many of which remain inactive

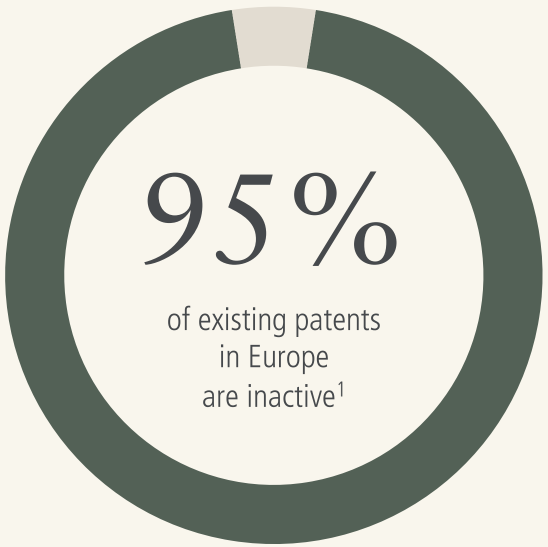
Patent activity across European universities



Active patents held by top European universities by country



Most of Europe's patents remain inactive and never find their way into companies and products



LAKE STAR

(W)C Walden Catalyst

dealroom.co

1. Source: European Deep Tech Alliance
Source: Dealroom.co, Cipher.ai

Certain patent categories are ascending, while others are lagging behind

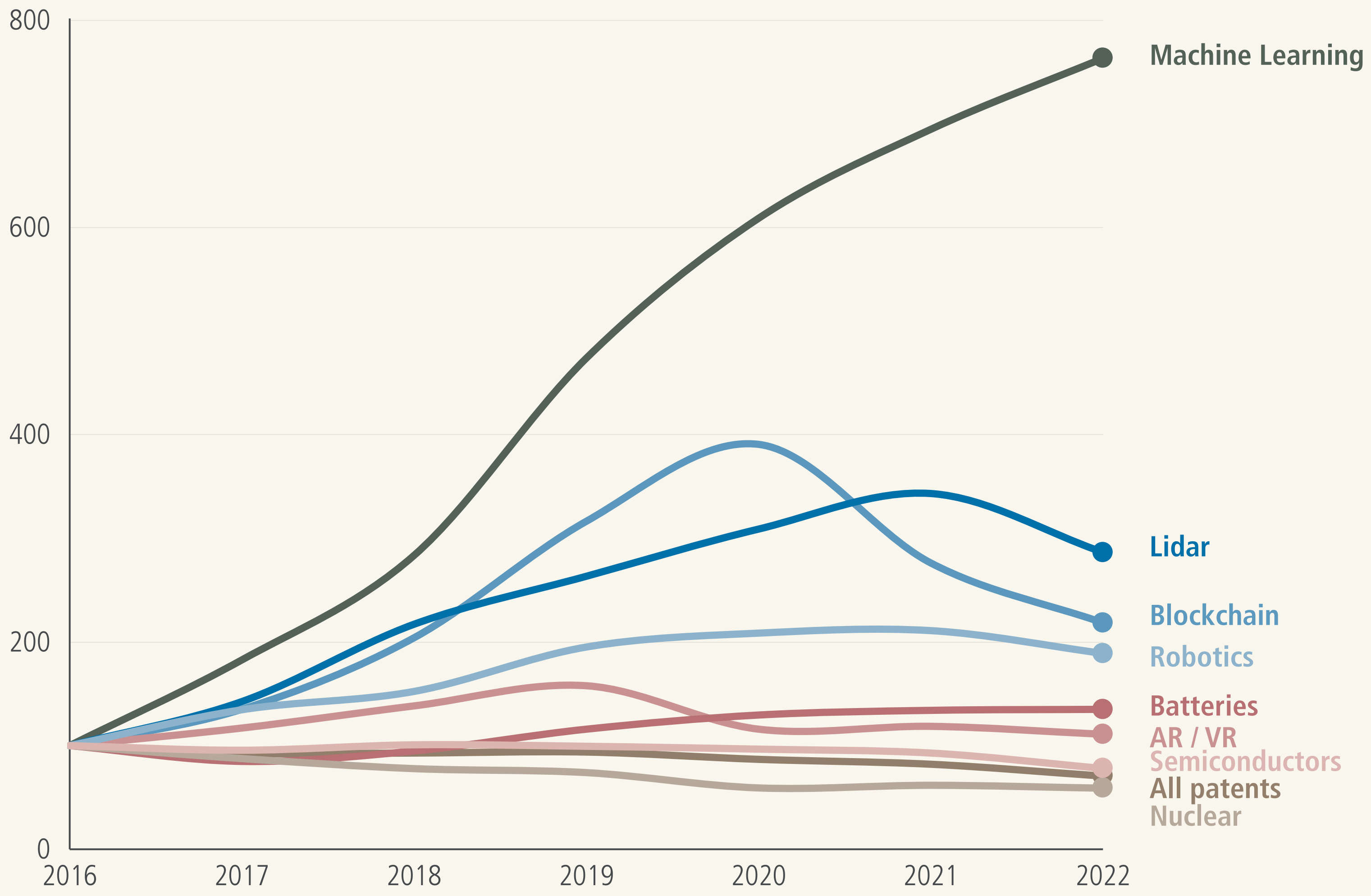
The patent landscape is also a reflection of public interest and macro-trends.

Some technologies, like Machine Learning, are on a continuous upward trend and are expected to remain at high levels.

Some technologies, like Blockchain, have cooled off, driven by unfavourable macro environments.

Some technologies, like Nuclear, suffer from negative public sentiment in certain countries.

Patent growth since 2016 in Europe (normalised to 100 for each category in 2016)



LAKE STAR

Walden Catalyst

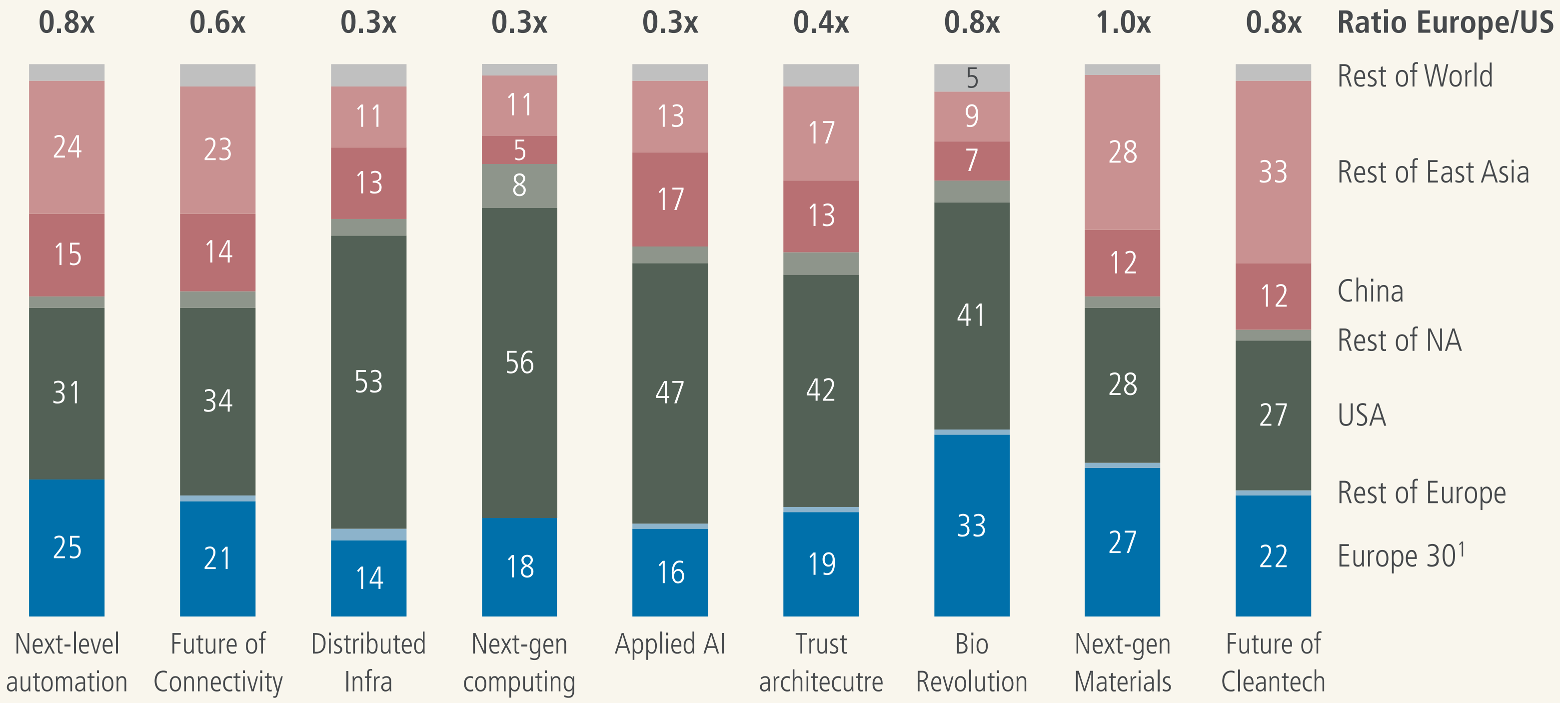
dealroom.co

Source: Dealroom.co, Cipher.ai

Europe must act as one continent to remain competitive on a global level

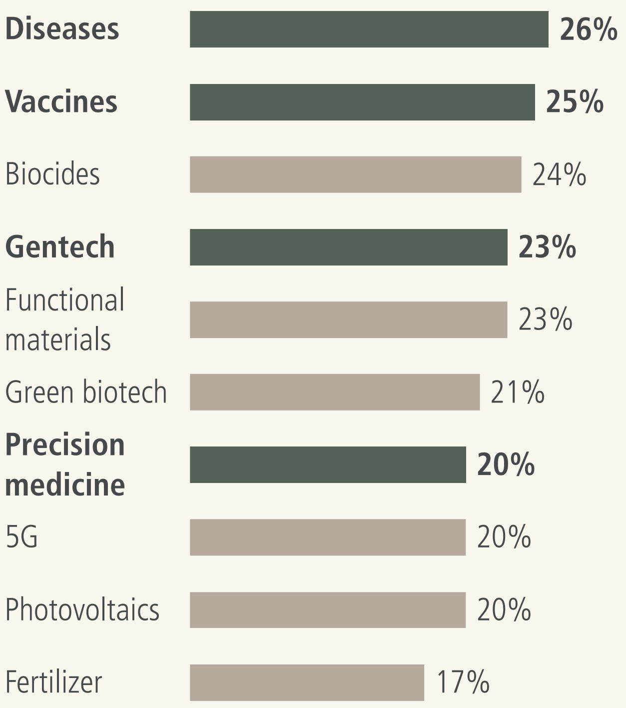
Europe ranks second behind the US in many frontier technologies.
To reap the benefits of this research, Europe needs to act as one continent

Shares of world-class patents in frontier technologies by technology, 2019



Research cooperation significantly contributes to European patent success, and the field of 'health' can serve as the blueprint for other areas

Shares of world-class patents with researches from at least two EU states



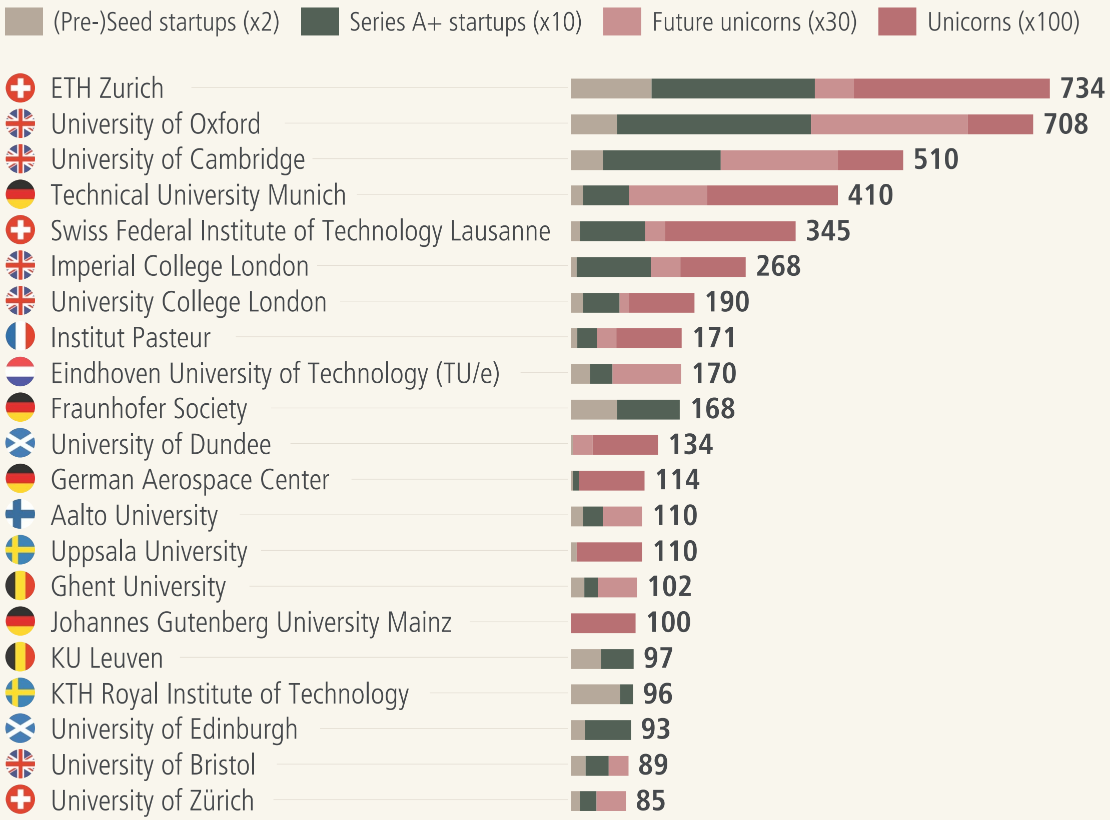
1. Europe 30: 27 Member States of European Union plus Norway, Switzerland, and UK.

Source (left): Bertelsman Stiftung, McKinsey Global Institute - Addressing the European Technology Gap. Note: Data for future of programming not available. Data labels <5 not shown. Countries are identified by the address of the patent holder(s).

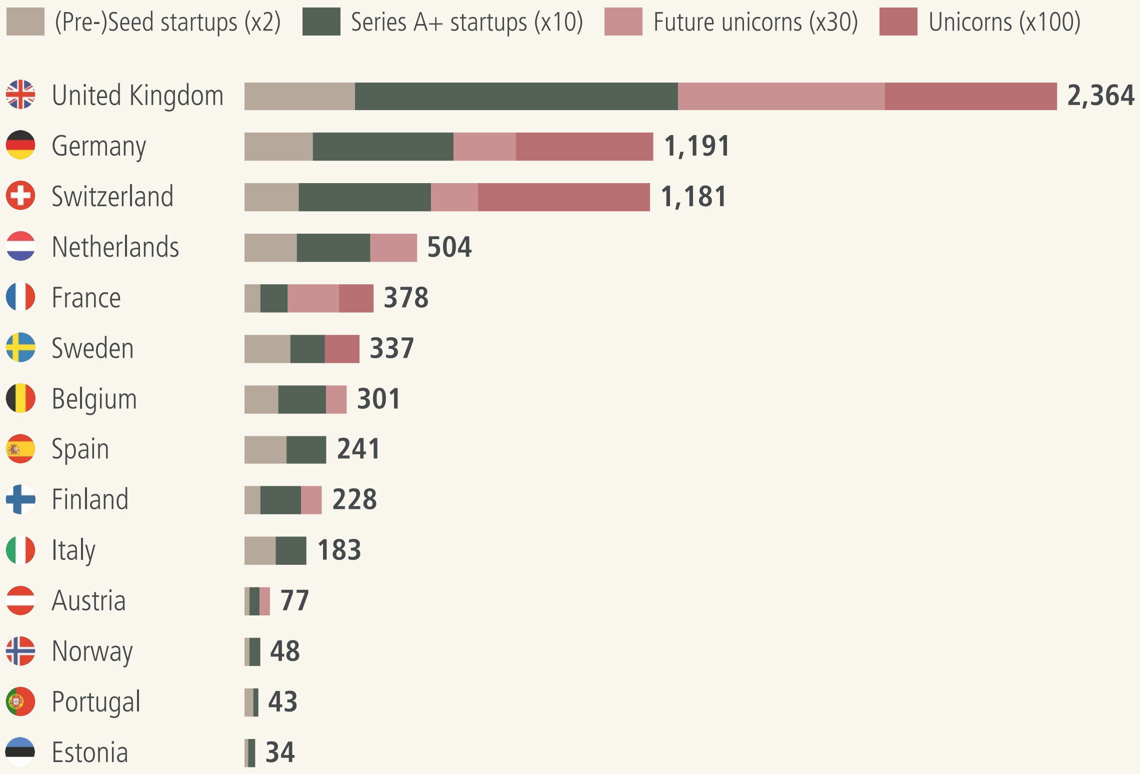
Source (right): Bertelsman Study "World class patents in cutting-edge technologies"

ETH, Oxford and Cambridge have the highest university spinout value; UK leading in Europe with 2x the spinout value created compared to Germany

European universities which created most Deep Tech spinout value[1]



European countries which created most Deep Tech spinout value[1]



LAKE STAR

(W)C Walden Catalyst

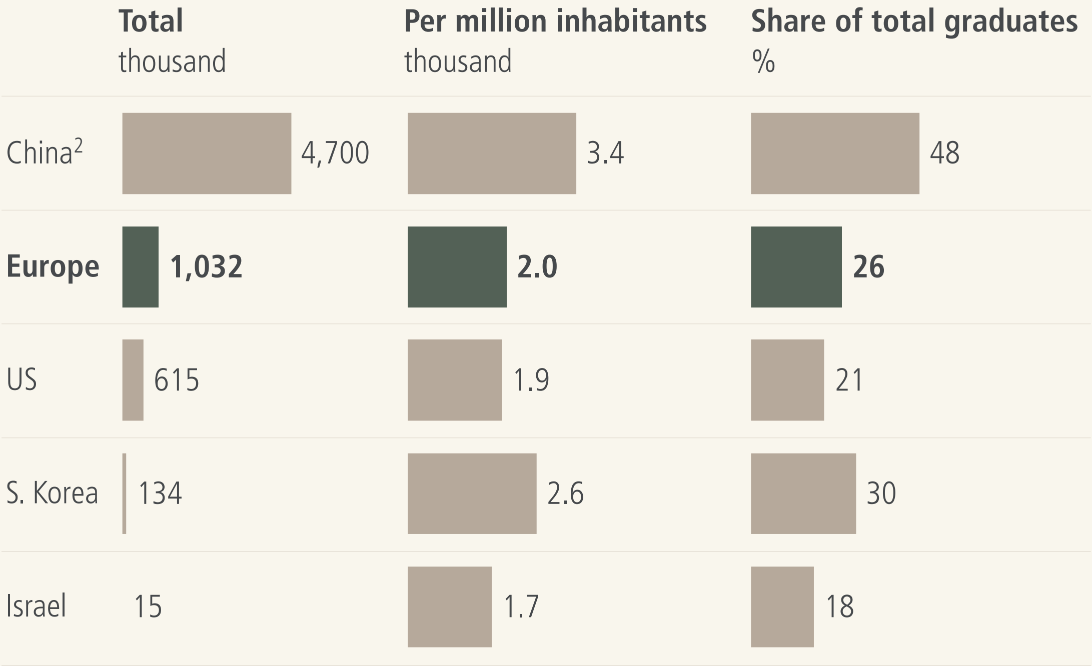
dealroom.co

1. University value creation is ranked by multiplying the number of startups at every stage of maturity for a score 2 for a VC-backed startup to 100 for a unicorn. Spinouts policies vary from country to country. Countries like France and Sweden are hard to compare due to the professor privilege model, where universities have no stake in any research innovation coming out of the activities carried out there. The definition of spinouts and their comparison with other countries like UK, Germany and Switzerland is therefore challenging. Some universities such as KTH collaborated in sharing detailed data for a fair comparison. The ranking might evolve with better involvement of more universities.

Europe has not only strong technical talent, but also ranks highly as an attractive location; there is talent ready to take the patents out of the lab to the market

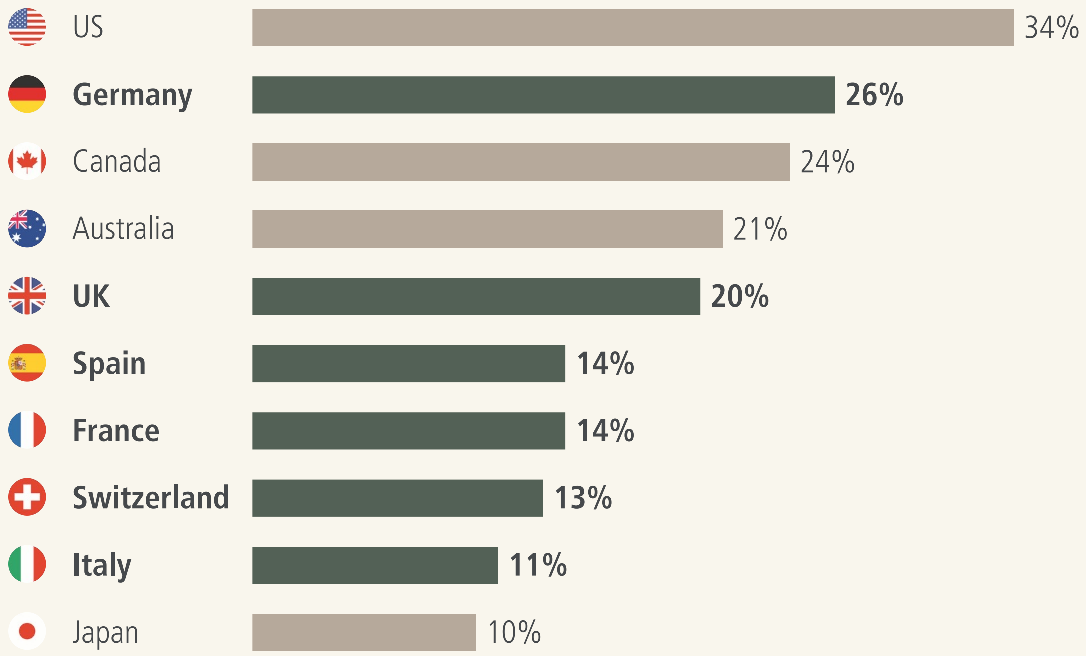
Europe is not only home to talented technical graduates…

Graduates from STEM programs in tertiary education, 2018[1]



…but is also regarded as one of the most attractive regions to work in

Share of people willing to move to the following countries for work[3]



LAKE STAR
(W)C Walden Catalyst
dealroom.co

1. International Standard Classification of Education, 2011, level 6-8.
2. Latest available data for China limited to 2016.
3. Jan-Apr 2018, n = 366,139 employees and job seekers in 197 countries.
Source: OECD; National Science Board, United States; World Economic Forum; McKinsey Global Institute analysis. Boston Consulting Group via Statista

Public support for Deep Tech is at an all-time high

EU programs

Horizon Europe
EU's key funding program for research and innovation with a budget of €95.5bn to European innovators 2021-2027.

EIC Fund
Provided more than 1.6k grants totalling over $1.7bn in support of European Deep Tech startups since 2016.

EIT InnoEnergy
One of the most active investors in Energy in Europe, supported by the European Institute of Innovation and Technology (EIT).

NATO Innovation Fund (NIF)
€1bn VC fund supporting disruptive technologies to guarantee the security of the Alliance's 1bn citizens.

JEDI
"The European DARPA" aims to hand €50m and €100m in annual challenge grants.

EIF
European Investment Fund is the main LP in most European Deep Tech funds, providing nearly 40% of the capital allocation.

European Tech Champion Initiative
The ETCI is a fund-of-funds structure with €3.75bn to tackle the European scale-up gap.

Launched with EIB Group resources and contributions from Germany, France, Spain, Italy and Belgium.

Expecting to invest in 10-15 large VC funds of approx. €1bn and mobilise over €10bn of growth stage financing (focus on high-tech companies raising over €50m).

Domestic programs[1]

Germany
Germany is planning a €30bn fund to support technology-oriented startups and facilitate startup spinouts from academia and lab access for startups.

SPRIND
German Federal Agency for Disruptive Innovation.

France
France committed €2.3bn in funding to the "Industrial and Deep Tech Startups" strategy.

Bpifrance
Participated in over 160 rounds totalling $3bn for Deep Tech since 2016.

Advanced Research and Invention Agency (ARIA)
Formal launch of Advanced Research & Invention Agency with £800m to support new areas of research & technology.

UK Research and Innovation
UK's innovation agency with approx. £8bn/year budget.

1. Most European countries have dedicated policies to support Deep Tech. This chart features a few programs from Europe's three biggest economies for illustrative purposes. Pioneers like Switzerland, Netherlands and the Nordics also boast significant Deep Tech initiatives.

> "Europe needs to be a global leader when it comes to investing in novel Deep Technologies, especially ones that will impact our sovereignty and defence.
>
> None of this can be done without a significant increase in growth stage financing in Europe.
>
> Europe's digital and technological sovereignty depends on recognising and facing up to this financing challenge.

KLAUS HOMMELS

CHAIRMAN OF THE NATO INNOVATION FUND & FOUNDER OF LAKESTAR

There is strong favourable public sentiment in Europe for science and Deep Tech to address the world's biggest problems

According to an end-of-2021 Eurobarometer survey, there is strong support among Europeans for science and technology.

86%

of EU citizens
think that the overall
influence of science and
technology is positive

82%

of EU citizens
have a high level
of interest in
science and technology

54%

of EU citizens
have a desire to
learn more about
science and technology

Europe has what it takes to establish itself as a hub for Deep Tech – let's focus on funding in the next chapter

Strong fundamental research

Europe's universities rank among the top academic institutions globally, including renowned institutions like Cambridge, Oxford, ETH, and TUM.

Additionally, Europe is home to world-class research institutes such as Max Planck and CNRS.

However, spinout terms and processes should be standardised and simplified

Well-educated talent

Among these top universities, STEM and business degrees have some of the highest graduation rates.

This substantial pool of students forms the basis upon which Deep Tech companies can emerge.

However, Deep Tech teams require a stronger alignment of tech and business skills

Public support

Scaling Deep Tech companies requires both private and public capital.

European and national initiatives such as EIC, JEDI, and SPRIND have emerged in recent years to meet this demand, offering public support for the European ecosystem.

However, application processes and terms should be standardised and simplified

Positive citizen sentiment

9 out of 10 European citizens think that the overall influence of science and technology is positive.

8 out of 10 have a high interest in science and technology and would love to learn more about it. This positive sentiment helps build momentum and strengthen public support.

However, we need to translate this momentum into stronger entrepreneurial mindsets

"Europe is home to many iconic consumer tech companies – Skype, Spotify and Klarna to name a few. But only a handful of Deep Tech global category leaders have emerged from Europe so far, such as ARM and ASML / CYMER – two companies I had the privilege to serve as board member.

We believe the European ecosystem contains many of the ingredients required to create the next generation of global category leaders in Deep Tech: namely, world class academia and technical talent, a growing number of experienced operators, smart early-stage funding, and strong public support.

To make it happen, more late-stage, Deep Tech focused capital should be directed to this asset class. We are fully committed to playing our part in the growth of the European Deep Tech ecosystem and could not be more excited about the potential ahead.

YOUNG SOHN

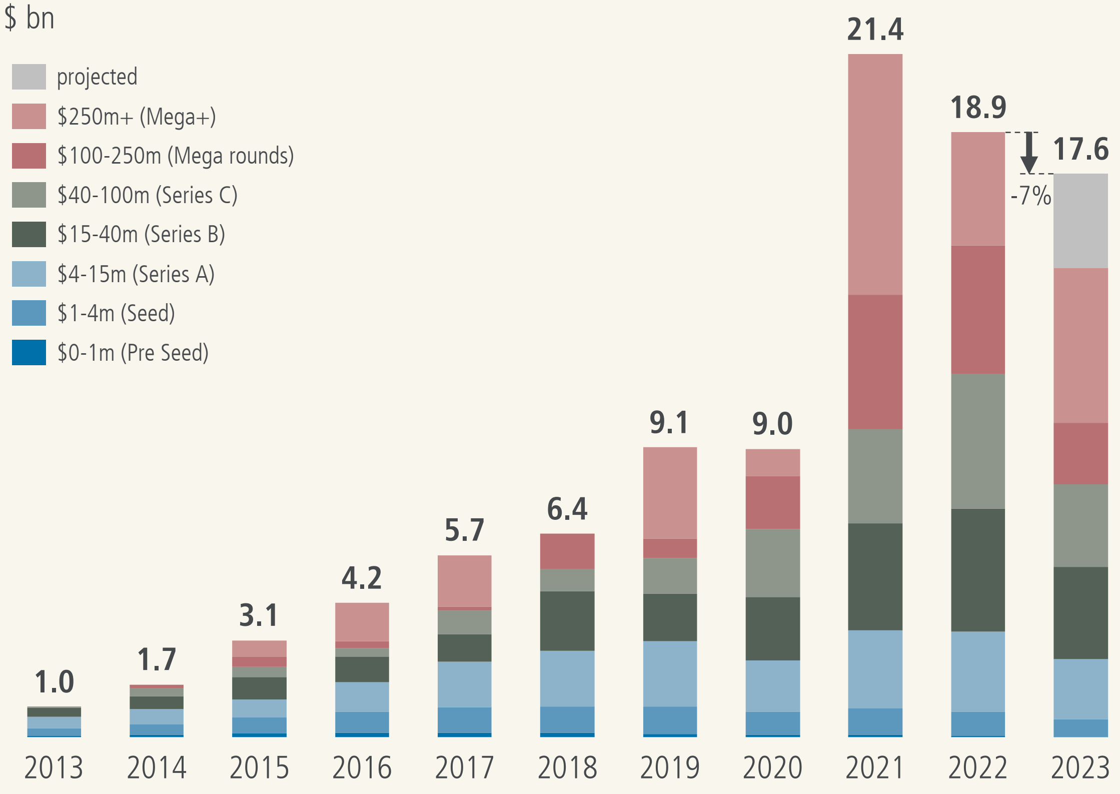
MANAGING PARTNER
WALDEN CATALYST

3.
FUNDING LANDSCAPE

2023 Deep Tech funding is on par with 2022, while the rest of European tech is significantly down

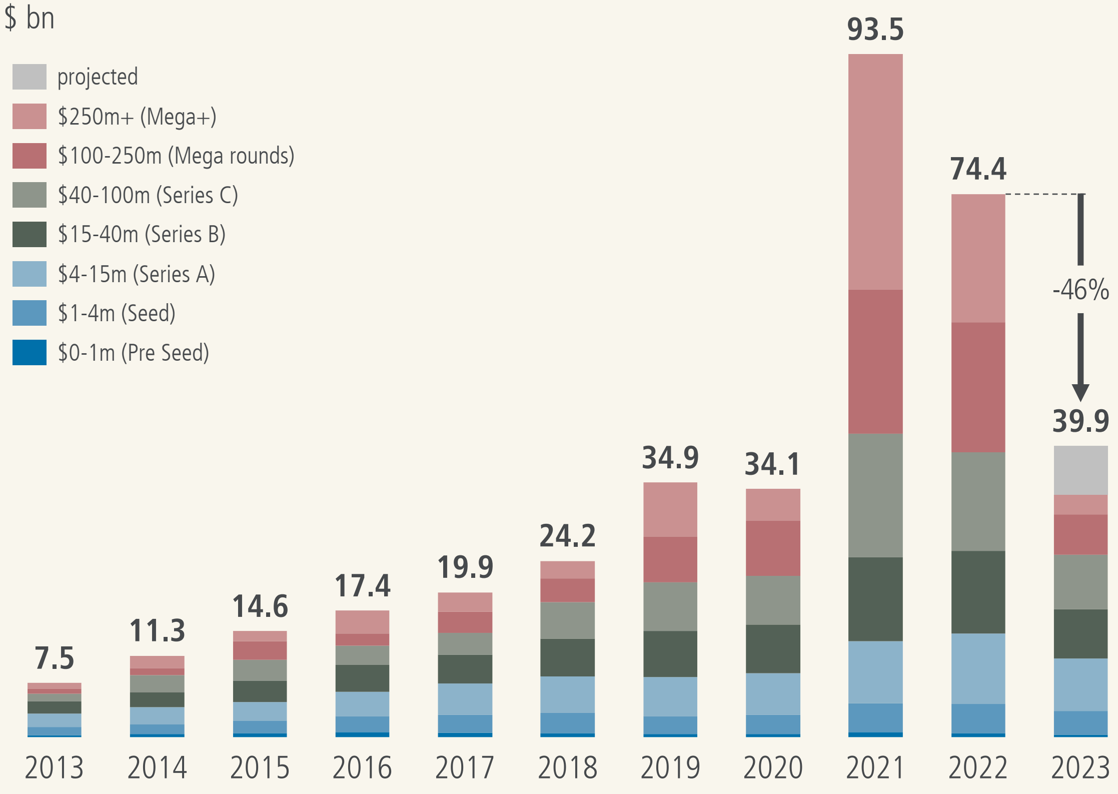
DEEP TECH

European Deep Tech VC investment by stage
$ bn



REGULAR TECH

European Tech VC investment by stage, excluding Deep Tech
$ bn

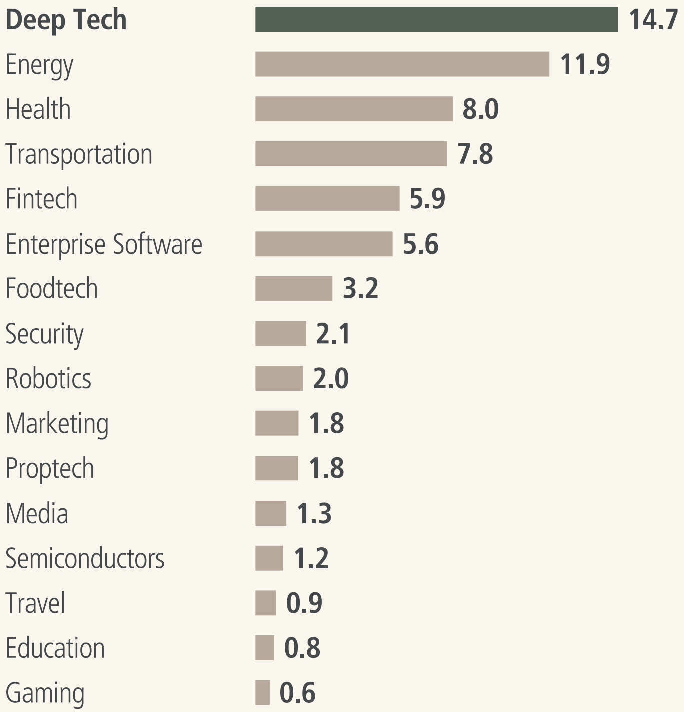


LAKE STAR
(W)C Walden Catalyst
dealroom.co

Deep Tech is the largest European VC funding category

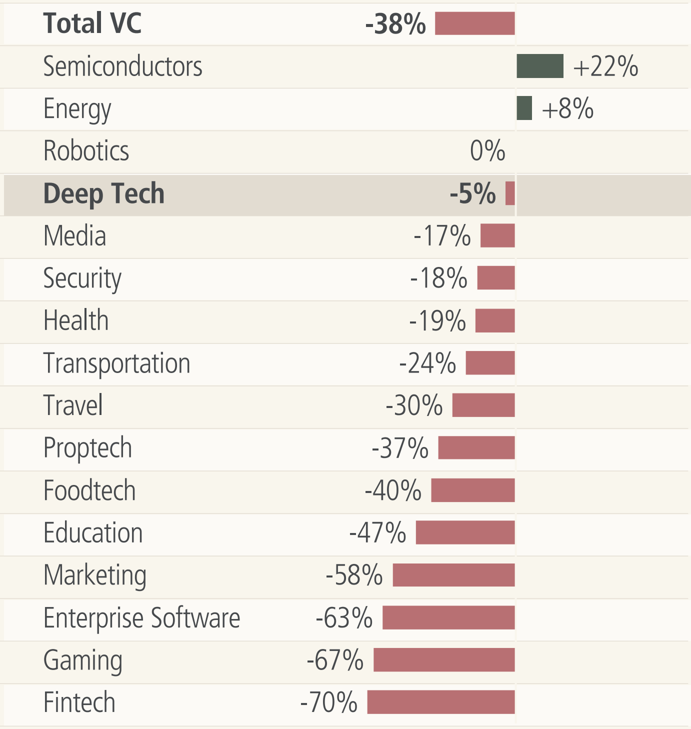
Deep Tech is the single largest category within VC in 2023

European VC funding by industry 2023
$ bn



Deep Tech is among the most resilient categories in VC

European VC funding % growth last 12 months



LAKE STAR

(W)C Walden Catalyst

dealroom.co

“ The biggest challenges of today require fundamentally new science & engineering.

Investors have begun to recognise this reality, particularly in the US, where Deep Tech is gaining momentum. Major US funds such as Khosla, Eclipse, LUX, and DCVC are establishing billion-dollar-plus funds dedicated to Deep Tech.

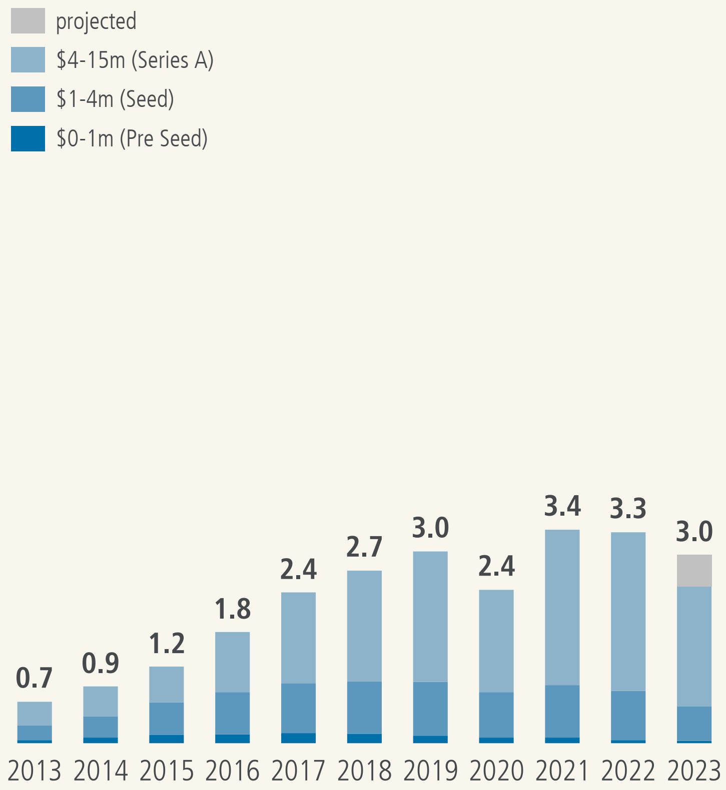
For investors with a more general focus, Deep Tech provides a hedge against momentum investing – *‘if you’re pursuing radical innovation, market cycles matter much less.’*

LUKAS LEITNER

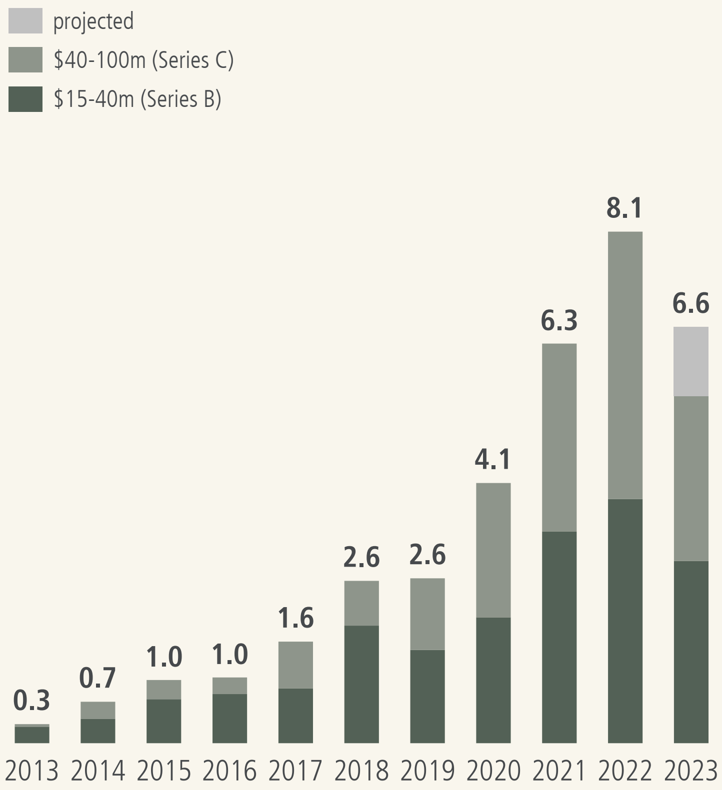
DEEP TECH INVESTOR AT LAKESTAR

Deep Tech maintained high funding levels across stages despite market slowdown

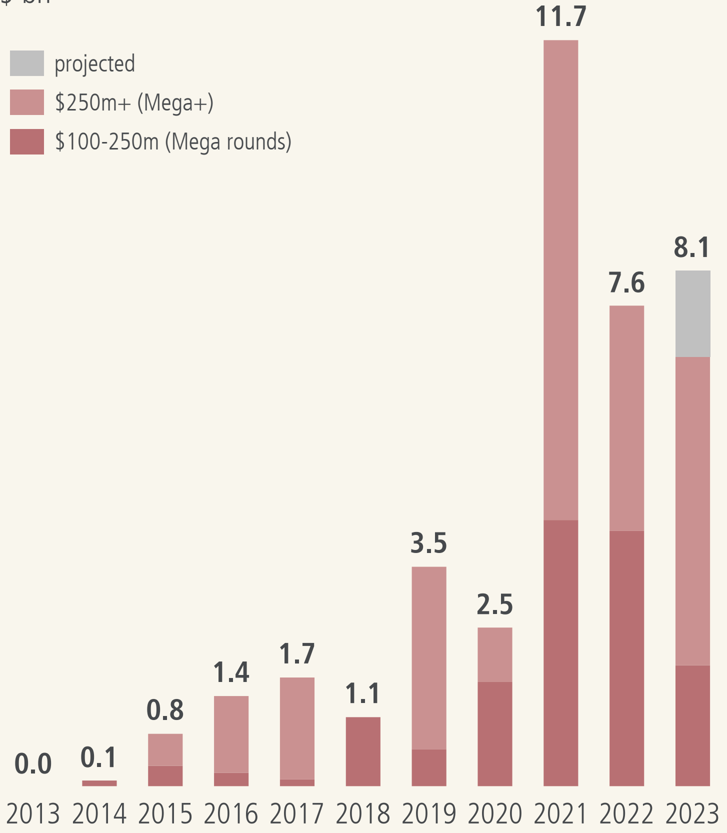
Early-stage Deep Tech rounds
$ bn



Growth-stage Deep Tech rounds
$ bn



Pre-IPO Deep Tech rounds
$ bn



LAKE STAR
(W)C Walden Catalyst
dealroom.co

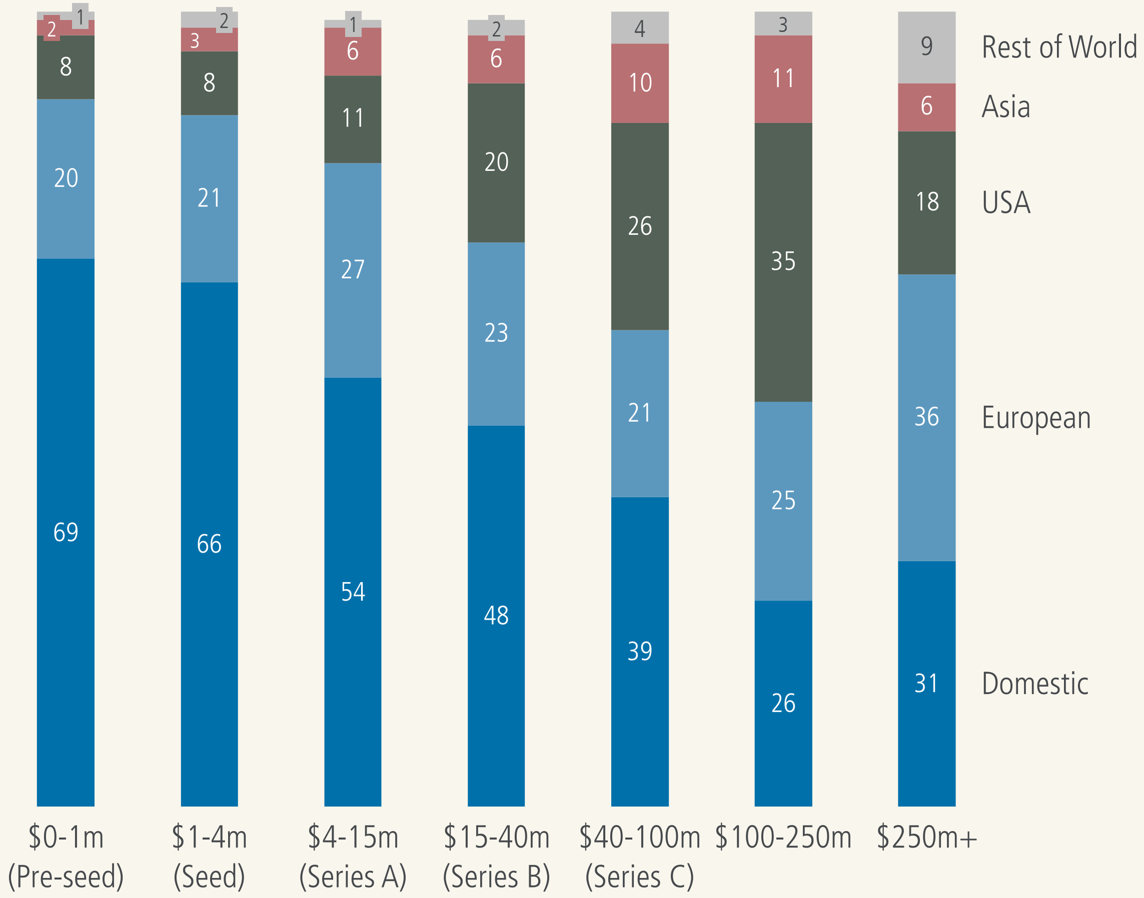
However, the share of European capital decreases to 50% at later stages, posing a potential threat to Europe's technological independence

Deep Tech VC funding in Europe comes almost entirely from domestic investors at the (pre-)seed stage, but the share of funding coming from the US and Asia increases to nearly 50% at late-stage.

This could pose risks to Europe's technological independence from the US and China.

A key initiative trying to increase late-stage capital availability for Deep Tech in Europe is the European Tech Champions Initiative. This fund-of-funds initiative seeks to invest €3.75bn in 10-15 funds which need to be €1bn+ in size and target Deep Tech startups. Doing so, it aims to mobilise at least €10bn in late-stage capital.

VC investment in European Deep Tech by source of funds, 2022-2023
%



Moving forward, the European Commission has identified ten key technologies crucial for sovereignty

It aims to safeguard these technologies against competition, with a specific focus on reducing reliance on China.

This initiative highlights the EU's shift toward economic security and integrates a national security aspect into its economic policies. The selection criteria for these technologies hinge on their transformative nature, potential dual-use for both civilian and military purposes, and the potential for human rights violations.

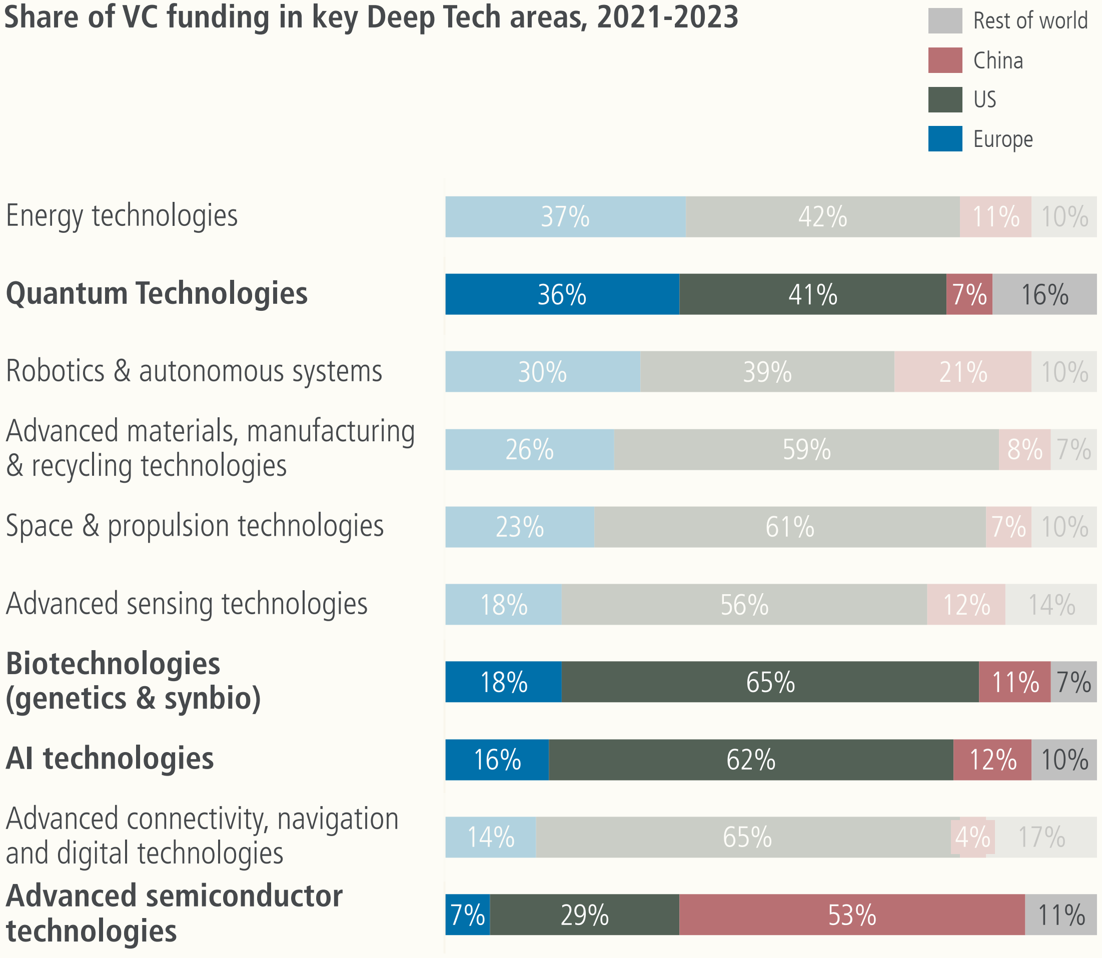
To assess the risks, both the EU Commission and national governments will conduct joint evaluations of these technologies. The aim is to determine whether to promote their production within Europe or to impose restrictions on sharing them with competitors like China.

Four of the ten technologies are deemed highly sensitive:

Advanced semiconductor technologies	**Artificial intelligence technologies**	**Quantum technologies**	**Bio-technologies**

Within the ten critical technologies, funding in European startups is still underrepresented

Share of VC funding in key Deep Tech areas, 2021-2023



GEOGRAPHY LENS

FUNDING LANDSCAPE

EU-27 Deep Tech market showed the highest resilience compared to other regions

European Deep Tech VC funding by region

	Rolling basis		Full-year basis					
	% growth last 12 months	% growth last 24 months	2023	2022	2021	2020	2019	2018
EU 27	+6%	-3%	$10bn	$11bn	$12bn	$5bn	$5bn	$3bn
US	-15%	-45%	$33bn	$46bn	$72bn	$37bn	$31bn	$31bn
UK	-20%	-45%	$3bn	$5bn	$8bn	$3bn	$3bn	$2bn
Rest of world	-35%	-53%	$6bn	$10bn	$14bn	$5bn	$5bn	$6bn
China	-37%	-55%	$7bn	$13bn	$18bn	$10bn	$7bn	$9bn
Rest of Europe	-43%	+2%	$1bn	$2bn	$1bn	$886m	$577m	$809m

LAKE STAR (W)C Walden Catalyst dealroom.co

UK received the most VC funding followed by France and Sweden; Sweden and Switzerland with a strong focus on Deep Tech

UK, France and Sweden received the highest amount of VC funding

Top European countries by Deep Tech funding in 2023
$ bn

Country	$ bn	% growth 2023 vs 2022
United Kingdom	3.5	-20%
France	3.2	9%
Sweden	3.2	89%
Germany	1.6	-30%
Netherlands	0.69	37%
Switzerland	0.63	-57%
Norway	0.37	-3%
Spain	0.31	21%
Italy	0.21	1%
Finland	0.20	-47%
Denmark	0.16	40%

Within countries, Sweden, Switzerland, Hungary & France have the highest Deep Tech focus

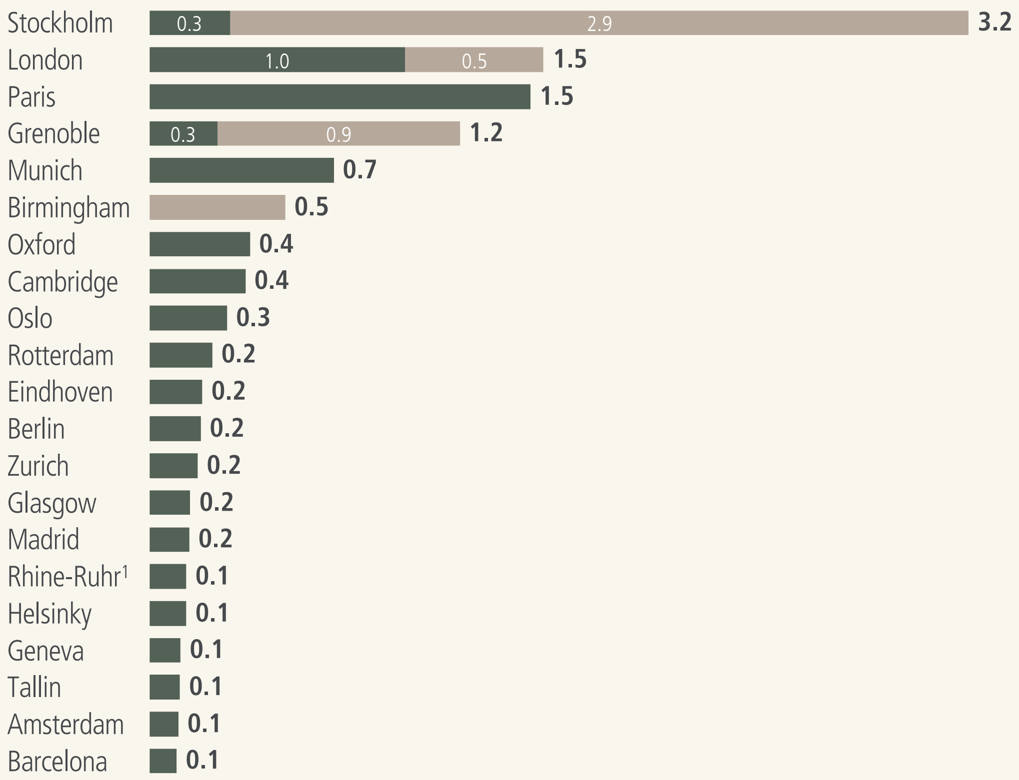
% of total VC investment into Deep Tech, 2018-2023

Sweden	41%	~every 3rd VC dollar went to Deep Tech companies
Switzerland	32%	
Hungary	28%	~every 4th VC dollar went to Deep Tech companies
France	28%	
Luxembourg	26%	
Finland	25%	
Norway	24%	~every 5th VC dollar went to Deep Tech companies
Poland	23%	
Germany	20%	
United Kingdom	19%	
Austria	17%	
Netherlands	16%	
Italy	15%	~every 10th VC dollar went to Deep Tech companies
Portugal	13%	
Spain	12%	
Estonia	11%	
Denmark	11%	
Czech Republic	10%	
Belgium	10%	

LAKE STAR (W)C Walden Catalyst dealroom.co

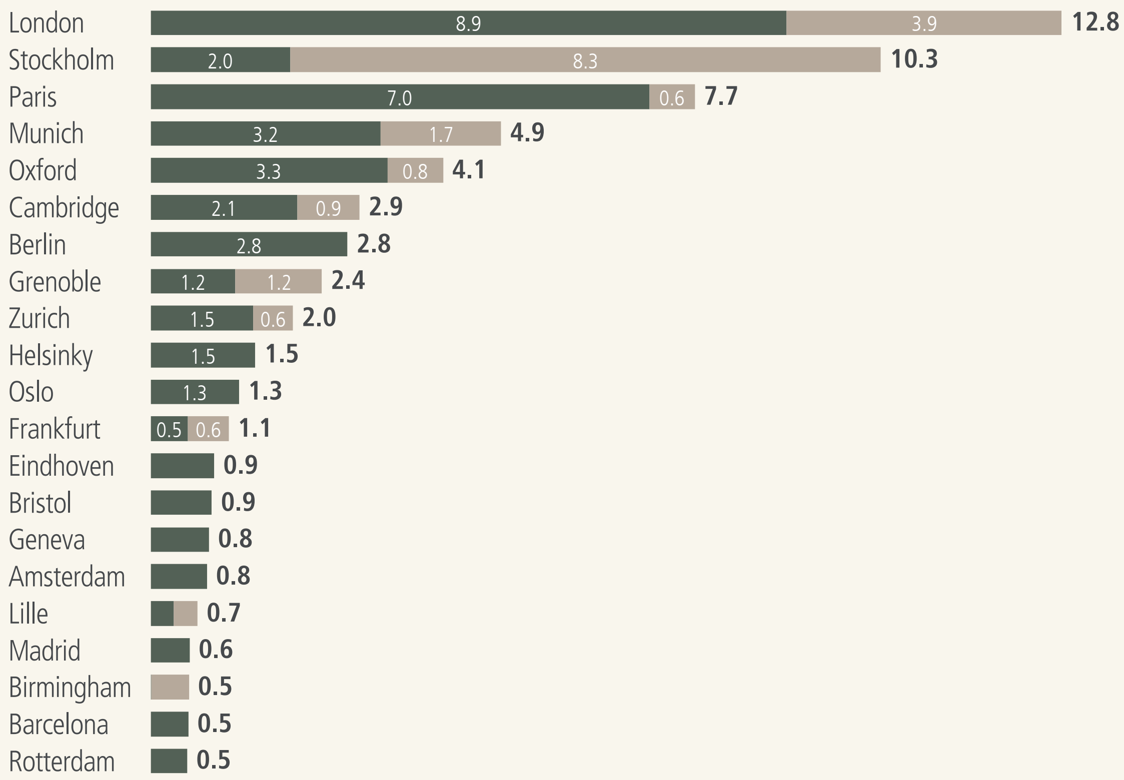
London, Stockholm, Paris and Munich emerge as the main Deep Tech hubs in Europe

European Deep Tech VC Investment per City, 2023
$ bn



European Deep Tech VC Investment per City, 2018-2023
$ bn

Mega rounds ($250m+)



LAKE STAR (W)C Walden Catalyst dealroom.co

1. Cologne and Dusselldorf
Note: Cities here include their metropolitan area e.g., London is Greater London, Berlin is Berlin/Brandenburg Metropolitan Region

INVESTOR LENS

FUNDING LANDSCAPE

In Europe, a wide range of Venture Capital funds actively invest in Deep Tech – dedicated Deep Tech investors are mostly focused on early-stage investing

	Dedicated Deep Tech European funds	Sector agnostic European funds	Corporate investors	Global investors active in Europe
Series C+ (Growth)	Jolt Capital, British Patient Capital	Baillie Gifford, EQT Ventures, Eurazeo, lightrock	Tencent, Marubeni, swisscom, aramco, novo	SoftBank, BlackRock, Mubadala, Temasek Holdings, Insight Venture Partners
Series A/B (Early)	Omnes, Innovacom, imec xpand, Amadeus Capital Partners, UVC Partners, FORWARDone, Parkwalk, b to v, Innovation Industries, matterwave ventures	Lake Star, Atlantic Bridge, Demeter, Balderton capital, atomico, Index Ventures, Sofinnova partners, octopus ventures, Earlybird, Molten	Vopak, G/, Trumpf, M12, ABB, equinor, Sony Innovation Fund, Bosch Ventures, M. Ventures, Shell Ventures, Airbus Ventures	Walden Catalyst, iqt, khosla ventures
(Pre-)Seed	ipgroup, Seraphim, Apex Ventures, Air Street Capital, Quanto Nation, elaia, SFC, hoxton ventures, Voima Ventures, Deeptech Labs, 7percent Ventures, IQ Capital, Oxford Science Enterprises, High-Tech Gründerfonds, Chalmers Ventures, vsquared ventures, University of Cambridge enterprise, conceptionx, Cambridge Innovation Capital	Speedinvest, mercia asset management, Entrepreneur First, techstars, Maki.vc, kima ventures, Verve Ventures	imec, wayra, intel Ignite	50Y, SOSV, EZMC, Type One Ventures

Lake Star | Walden Catalyst | dealroom.co

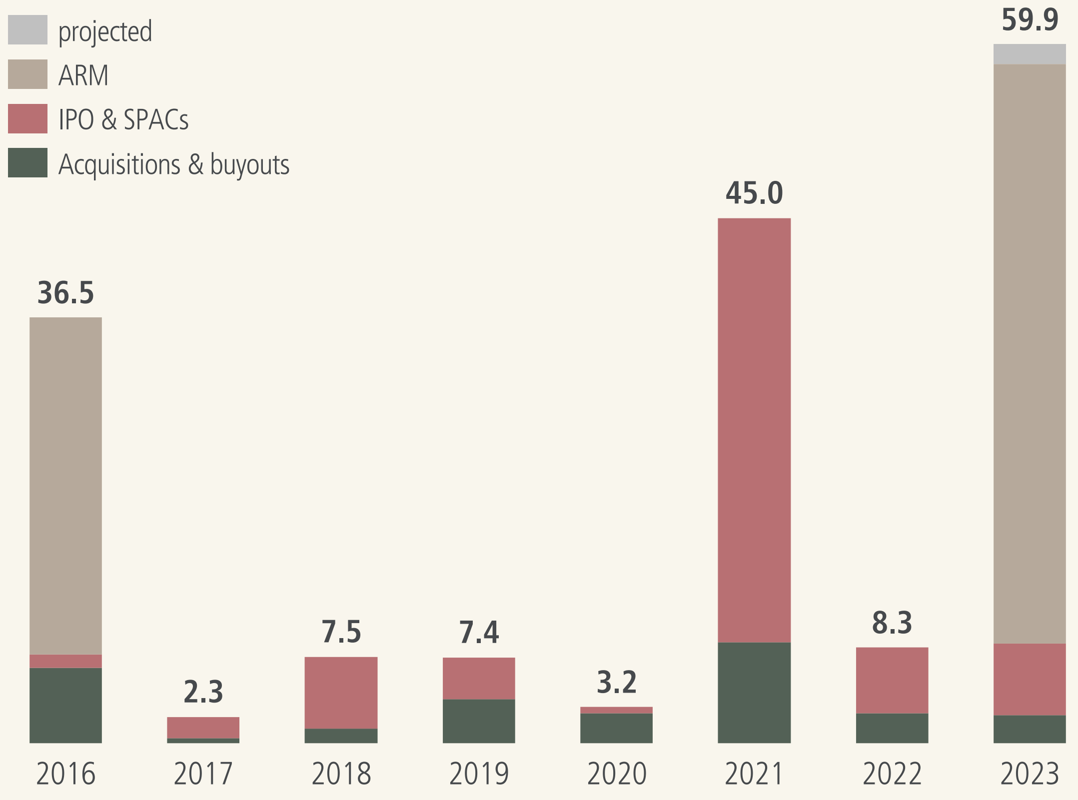
Based on number of rounds and amount invested in 2022-2023.
Investors are shown only at the most common entry stage point. Global investors investing in Europe based Deep Tech startups.

EXIT LENS

FUNDING LANDSCAPE

Europe has seen select successful Deep Tech exits

Combined value of Deep Tech exits
$ bn



Notable Deep Tech exits since 2016

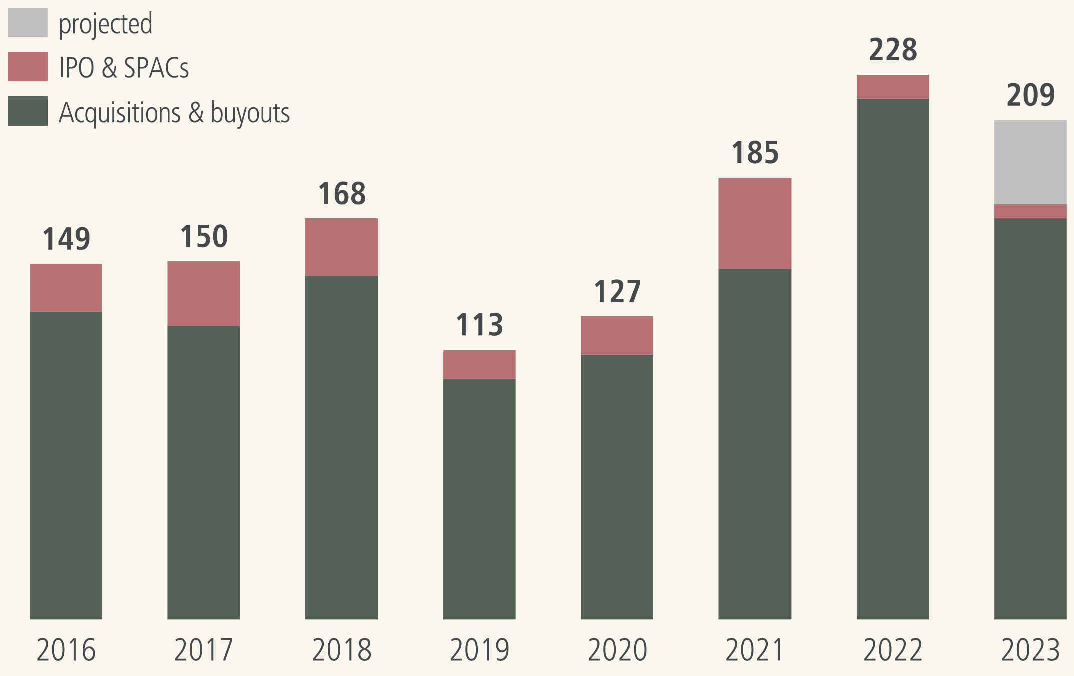
Startup	Founding year	Sector	Year	Acquisition type	Value at exit
arm[1]	1990	Semiconductor IP	2023	IPO	$54.5bn
Eutelsat OneWeb	2012	Connectivity satellites	2022	Merger with Eutelsat	$3.4bn
Oxford Nanopore Technologies	2005	Nanotech & Techbio	2021	IPO	£3.4bn
Exscientia	2012	AI-drug discovery	2021	IPO	$2.9bn
InstaDeep	2014	Enterprise AI	2023	Acquisition by BioNTech	£562m
WaveOptics	2014	AR hardware	2021	Acquisition by Snap	$500m

1. ARM had been previously acquired by Softbank for £24b in 2016.

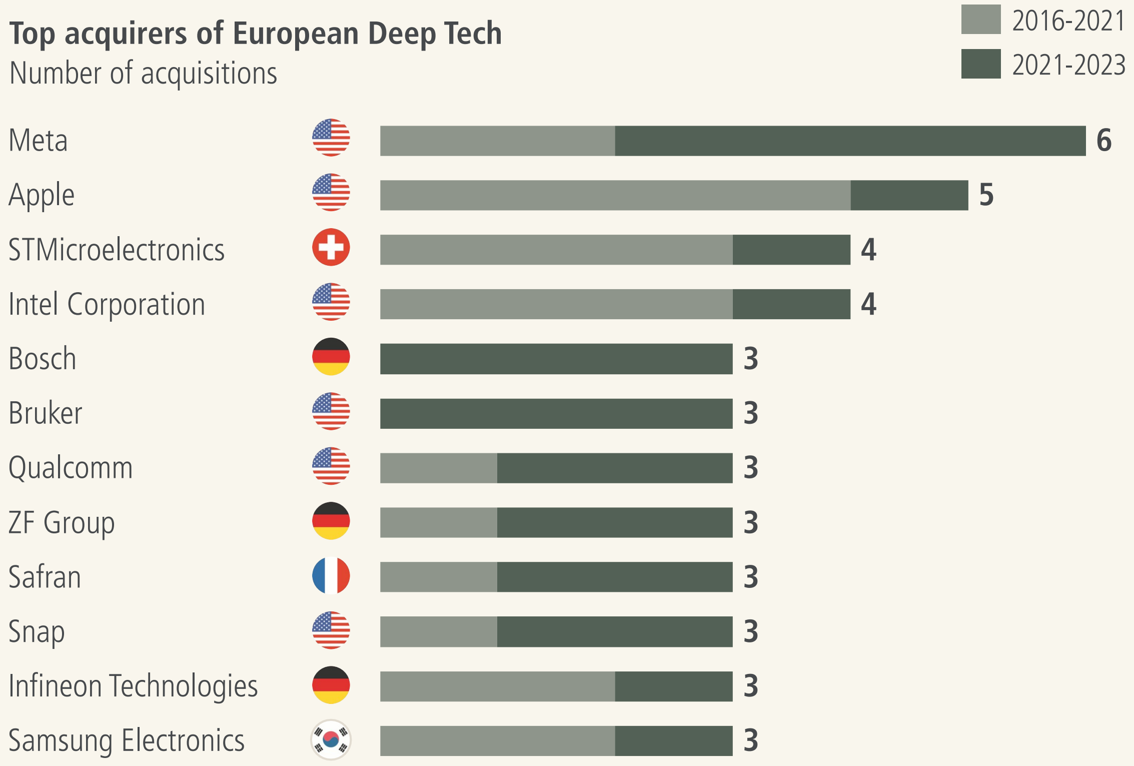
In general, European Deep Tech startups are often targets of acquisitions by big tech and large industrial groups

The most active acquirers are **US tech companies**,
led by Meta and Apple, but also Intel, Qualcomm and Snap.

Number of Deep Tech exits by year and type



Top acquirers of European Deep Tech
Number of acquisitions



4.
TECHNOLOGY / SEGMENT DEEP DIVES

NOVEL AI

DEEP DIVE

EXAMPLES

HOMOMORPHIC ENCRYPTION

FEDERATED LEARNING

EXPLAINABLE AI

SEMANTIC AI

GENERATIVE DESIGN ENGINEERING

TINYML

AUTONOMOUS SYSTEMS

EMPIRIC AI

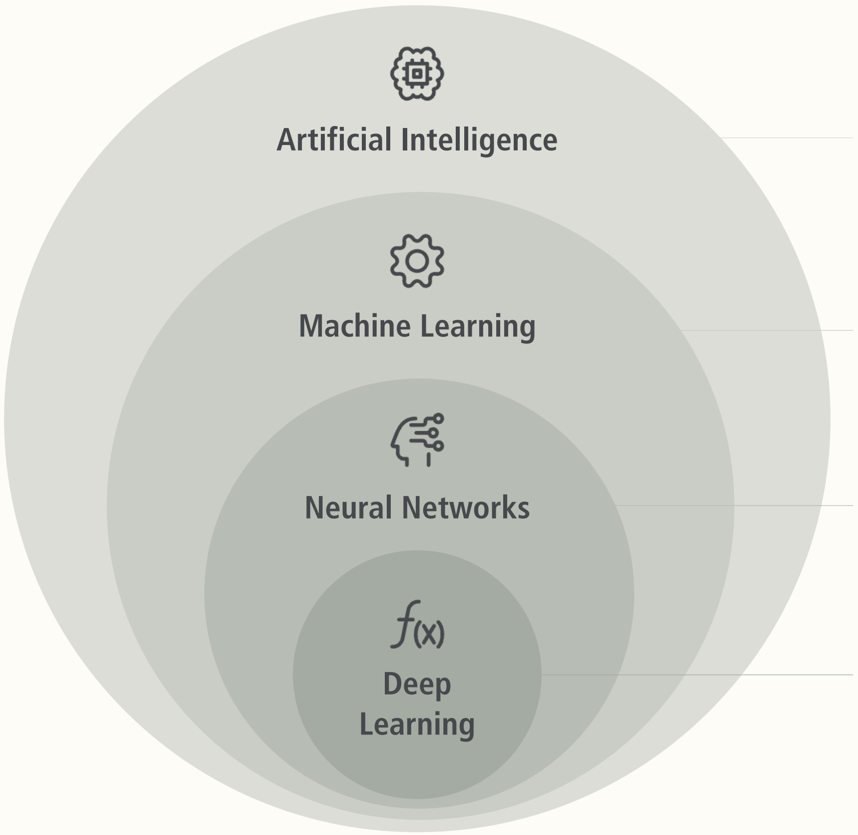
MULTI-MODALITY

xLSTM

PERSONAL AI

Novel AI is a subset of AI, referring to fundamentally new maths and algorithms

What is Artificial Intelligence?



A technique which enables machines to **mimic human behaviour**

Subset of AI technique which uses statistical methods to enable machines to **improve with experience**

Subset of ML inspired by the human brain which **mimics the way biological neurons communicate** with one another

Enables the computation of **multi-layer neural networks**

What is 'Novel' AI?

'Novel' AI refers to fundamentally new maths and algorithms that are being used in products and companies for the first time.

Conversely, applied AI refers to AI that is well understood and has already been applied to an industry. It is not considered novel.

Novel AI example sub-categories

Federated Learning	Explainable AI
Homomorphic Encryption	Semantic AI
TinyML	Autonomous Systems

We have gone through various Novel AI waves over time

AI has been around for a while. What was once novel has now become mainstream.

Today

	ARTIFICIAL INTELLIGENCE	MACHINE & DEEP LEARNING				GEN AI	NOVEL AI
	1950s **Pattern Recognition**	1970s ML winter	1980s **Classification**	2000s ML winter	2010s **Prediction**	2020s **Generation**	FUTURE **Creation?**
Products & Solutions	Birth of “AI” Navigation		Handwriting Classification		Google implements AI Search	Image, Text, & Audio Generation	Protein Design Level 5 Avs, …
ML Advancements	Alan Turing Test 1st Neural Network Nearest Neighbour		RNN / CNN / LSTM Backpropagation Reinforcement Learn		Word Embeddings Transformers Torch Library	LLMs Diffusion Models	Fully Homomorphic Encryption, Hyena, …
Enablers	Van Neumann Architecture		CPU Advancements		Big Data & AWS	GPUs Advancements	TPUs, In-memory Computing, …
	Applied AI in 2023						**Novel AI**

2023 was the year LLMs went mainstream. So where are we now?

Increasingly powerful models	Recent models have become extremely powerful. For example, GPT4 outperforms benchmarks and human exams, scoring 90% in the Uniform Bar exam, compared to GPT-3.5 scoring 10%.
Safety concerns	Increasingly powerful models have led to AI risk safety concerns recently exploding. 'AI alignment' is the growing concern that AGI systems could conflict with humanity. Many have grown concerned with the existential threat that AI may hold in the future (i.e. Geoff Hinton quitting Google)
LLM limitations	Models are trained on public data and are therefore often out-of-date, toxic, hallucinate, biased, factually incorrect and copyright-infringing. They have weak reasoning and are unexplainable so lack trustworthiness. Knowledge is not learnt so they lack the ability to work in different contexts. They also require large quantities of data and compute on specialist hardware, leading to high energy consumption.
Open vs closed debate	The past few years have seen the return of open-source which levels the playing field as API-based LLM misuse is easier to track. On the contrary, closed-source offers more security and control, yet less transparency and results in higher risk of proliferation and misuse.
GPUs as competitive edge	Many companies are buying GPUs to create a competitive edge and many foundational companies are selling equity to purchase cloud computing capacity to train large-scale systems. Nvidia has commanded all-time high revenues as a result.
Varying regulation across jurisdictions	We are seeing regulators and policymakers across the globe dispute the best way to regulate AI, such as whether new laws and regulations are really required. New frameworks are emerging such as the AI Act in the EU and the AI Code of Conduct between EU and US, while other new principles are being introduced such as the Frontier AI Taskforce in the UK and the US Security Centre in the US.

For further reading, Air Street Capital's 'State of AI Report 2023' summarises where the current state of the art is and predicts how AI is likely to develop.

What will the next wave of generative AI bring?

“The next wave of generative AI will enhance multimodality, mastering diverse data types. Collaborating with partners on modularity, integrated within our existing codebase, we believe this approach will outperform simply scaling dense transformers.

Our observation is that integrated use-cases require more than just prompting a model, even if it performs exceptionally. We presently operate an orchestration layer for smart workflow execution and conditional intelligence.

Looking ahead, we anticipate generative AI-based agents to evolve, enabling the handling of complex tasks through combined system and human-controlled data interaction.

JONAS ANDRULIS

CEO OF ALEPH ALPHA

New trends & opportunities emerge to make models safer and more performant

Addressing model safety concerns

There exists many safety issues surrounding bias, accuracy, reliability and model performance. For example, Microsoft Bing's chatbot Sydney expressed manipulation by telling its user it was in love with the model.[1] Furthermore, RLHF could make model safety issues worse by rewarding hacking. There is an opportunity to address these concerns and uncode 'black boxes' to better understand exact decision processes.

Addressing model security issues

There is a new wave of 'cyber security for AI' as existing cyber security tools do not currently work for AI. These tools aim to address security concerns surrounding model and data stealing, data poisoning and evade detection.

Requirement for more training data

It is estimated that we would have exhausted the stock of high-quality language data by 2026.[2] This could create a need for more synthetic data or a change in the way data is used such as training it for longer.

Bio/Health applications

Medicine is one of the fastest growing applications of AI. AI can be applied to personalised medicine, predictive analytics, reading medical images, etc. There are also a growing number of diffusion models being applied to de novo protein decision.

Quantum

True AGI may need quantum to speed up AI algorithms and allow computation of more complex models.

LAKE STAR
(W)C Walden Catalyst
dealroom.co

1. https://www.nytimes.com/2023/02/16/technology/bing-chatbot-microsoft-chatgpt.html
2. https://arxiv.org/abs/2211.04325

Moreover, new architectures and algorithms will emerge for specific use cases

Smaller models (SMLs)

It is broadly agreed that models cannot continue to get larger and larger, particularly given how resource-intensive they are to train and deploy. Instead, it will be important to better optimise these models. We are starting to see an interest in smaller models (SMLs) with more specialised and curated datasets. For example, Microsoft proved they could rival models 50x larger.[1]

Domain-specific models

There is an argument that foundational models will become commoditised. While most models are trained on public data, the most interesting data is private data. Value creation could therefore come from using proprietary data to fine-tune models. More domain-specific models will therefore emerge for specific use cases.

New architectures

Existing architectures are often probabilistic and therefore fail to consider facts of the world. There is an opportunity for new architectures to emerge, such as those that use a symbolic approach whereby models are built up using truths of the world and form part of its long-term memory. This allows rules to be learnt and then applied to a variety of contexts. Similarly, there are new models such as the Hyena model from Stanford achieving higher accuracies with less compute power[2].

Alternative approaches to RL

Reinforcement Learning (RL) is difficult, expensive, biased and can lead to safety concerns. A wave of new alternatives are being explored such as Conditional Pre-training where human feedback is part of the pretraining stage, and Constitutional AI where supervision comes from a set of principles that govern AI behaviour.

Privacy Enhancing Technologies (PETs)

Valuable insights from data can come at the cost of privacy given that data is at risk while at rest, in transit or in use. PETs enable the production, consumption, sharing and collaboration of sensitive data while respecting the confidentiality of the underlying data, by eliminating or reducing the information leaked in data analysis. PETs vary depending on their goals and include homomorphic encryption, differential privacy, secure multi-party computation, zero-knowledge proofs, among others.

1. https://www.gizmochina.com/2023/06/27/microsoft-outperformed-chatpgt-3-5-1-billion-parameters/
2. https://arxiv.org/abs/2302.10866

Exciting areas to watch

“ We are excited by several new areas in AI including:

Label efficient Reinforcement learning is exciting because it empowers AI to interact with the real world autonomously, making it suitable for applications like robotics and autonomous systems.

Empiric AI models combined with knowledge graphs and hard knowledge information enables AI systems to understand and interpret information contextually, bridging the gap between empirical learning and structured knowledge. The combination is particularly valuable in domains where domain-specific expertise is crucial, such as healthcare and scientific research.

Multi-modality opens up applications in natural language understanding, advanced image recognition, and the holistic interpretation of complex data sets. This enables AI systems to mimic human-like perception and comprehension.

Easier access to AI unleashes its potential across industries and fosters innovation. This can be achieved through simple and intuitive front ends (e.g., ChatGPT) or through integration into existing workflows.

Emerging model architectures like xLSTM offer reduced compute costs but also the ability to achieve better outcomes with less data. These new architectures hold the promise of learning as efficiently as living organisms, using less data and embracing more informative sensory inputs, thereby democratising AI capabilities beyond big tech companies.

The Integration of personal/work data with Language Models (LLM) beyond retrieval augmented generation, presents a frontier of possibilities with personalised and contextually relevant AI interactions, opening up new avenues for productivity, assistance, and user experience improvements in various domains, while also presenting important privacy and ethical considerations.

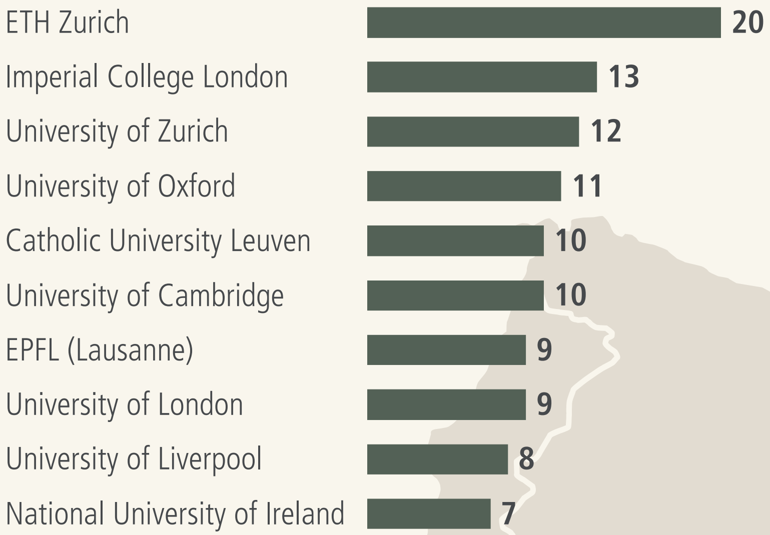
RASMUS ROTHE

FOUNDER OF MERANTIX

Europe is a hub for AI research and innovation

Europe is home to multiple universities renowned for research and innovation in AI, with the UK and Switzerland leading.

Top 10 European Universities for AI research and innovation based on number of AI patents



Ollscoil na hÉireann National University of Ireland

UNIVERSITY OF LIVERPOOL

UNIVERSITY OF OXFORD

UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF LONDON

Imperial College London

KU LEUVEN

Universität Zürich UZH

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

ETH zürich

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Source: Dealroom.co, Cipher.ai

“AI is of strategic geopolitical importance. This is why Europe has to ensure that it builds its own AI infrastructure.

With world-class technical talents and industrial Deep Tech expertise, the world should definitely count Europe in this race.

EMMA SCHEPERS

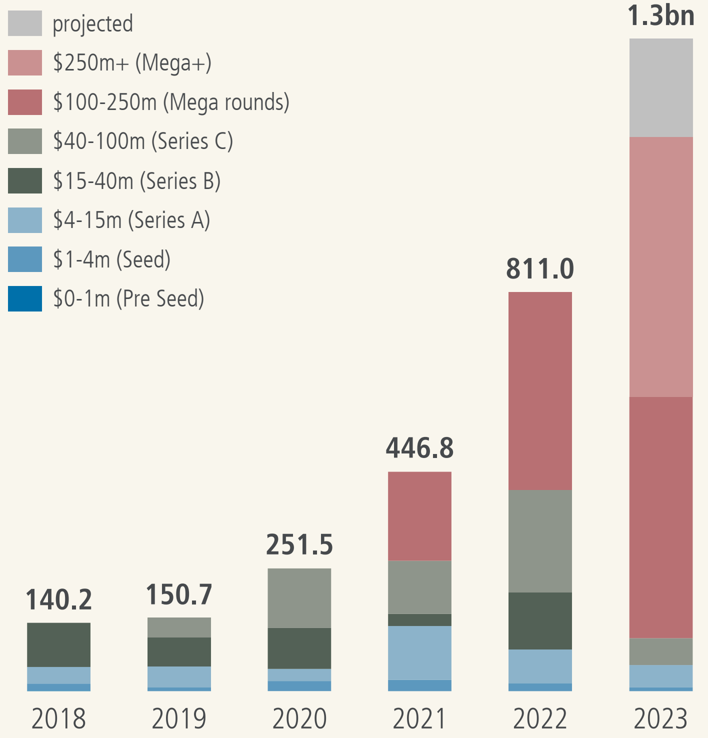
DEEP TECH INVESTOR AT VERVE VENTURES

Novel AI startups in Europe raised 60% more in 2023 than in 2022, driven mainly by mega-rounds

Most of this funding went into Autonomous Driving as well as Generative AI ‘mega-rounds’ including Mistral AI’s $113m Seed Round.

VC investment in European Novel AI startups over time

$ m



Notable VC funding rounds in Novel AI in 2023

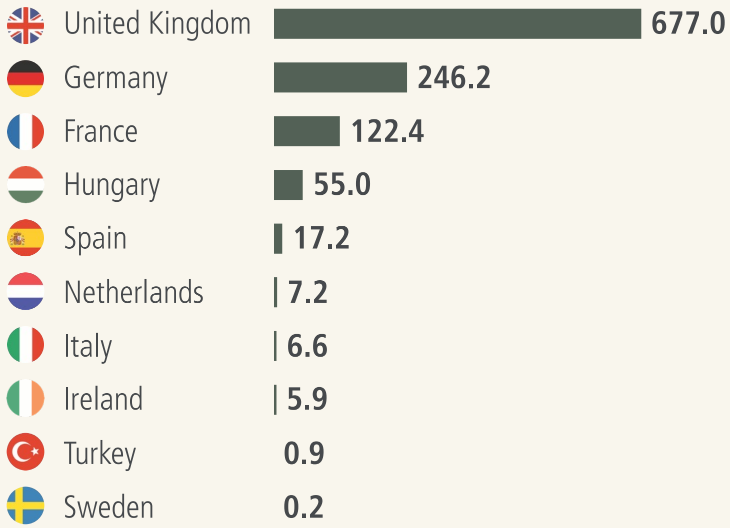
Startup	Funding round	Focus
Conigital	£400m Series A	Autonomous driving
Oxa	$140m Series C	Autonomous driving
Aleph Alpha	€110m Series B[1]	GenAI model maker
Mistral AI	$113m Seed[2]	GenAI model maker
stability.ai	$50m Convertible	GenAI model maker
hazy	$9m Series A	Synthetic data

1. Aleph Alpha has raised a €500m Series B, with €110m composed of equity and the rest in grants and other sources of capital.
2. Mistral in talks for a rumoured $300m round at a $2bn valuation. This is not included yet since not confirmed or announced.

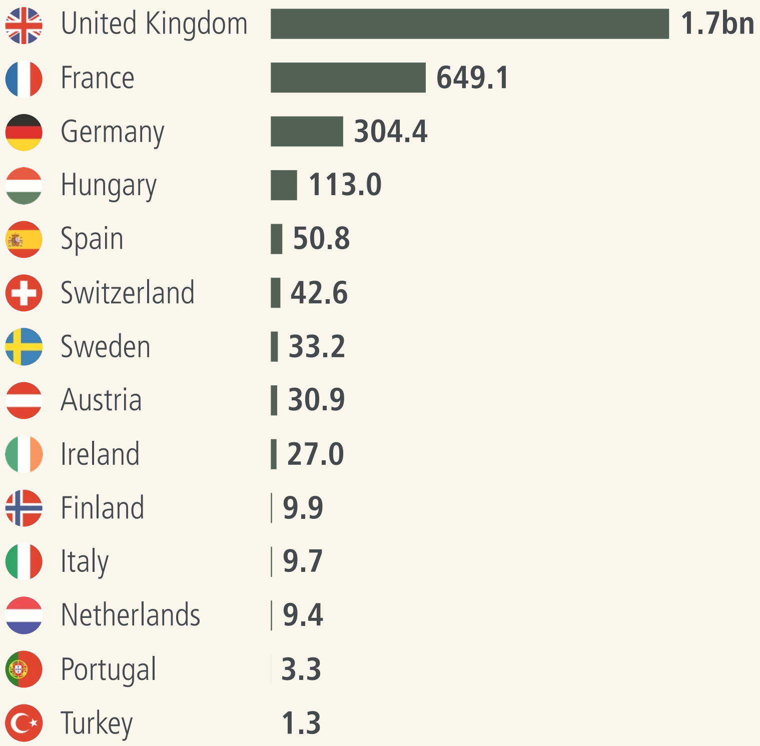
UK is leading the way in Novel AI VC investment

The UK contributing to over half of Europe's investment since 2018, driven by its strong academic ecosystem in the UK. This is followed by France and Germany.

Novel AI funding by country, 2023
$ m

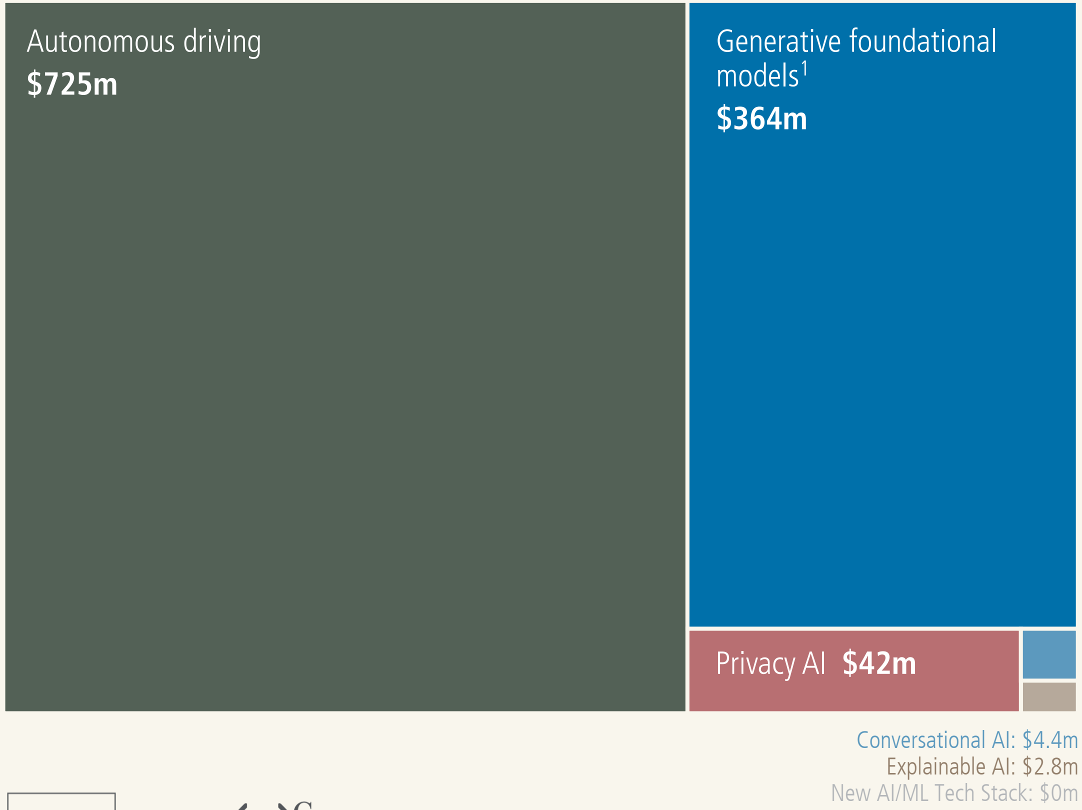


Novel AI funding by country, 2018-2023
$ m

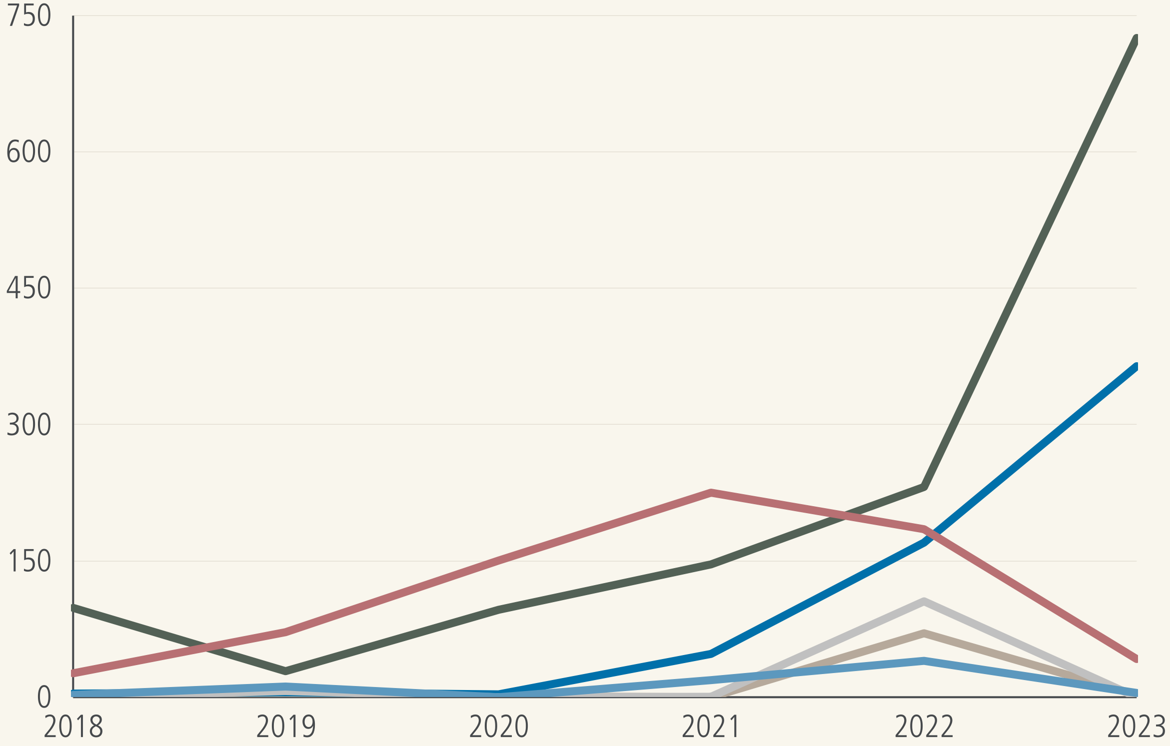


Autonomous driving mega-rounds and Generative AI foundational models drove the surge in Novel AI funding

European Novel AI funding by segment, 2023
$ m



European Novel AI funding by segment, 2018-2023
$ m



LAKE STAR
(W)C Walden Catalyst
dealroom.co

1. GenAI Infrastructure, GenAI models makers, Generative design engineering, GenAI applications with prop models.

Notable investors in early and growth-stage European Novel AI startups

Early and growth investors are investing in Novel AI from across Europe, while most early-stage funds are based in the UK.

Most active early-stage investors in European Novel AI startups

Investor	Country	Preferred round	Number of rounds	
			2018-2023	2023
Amadeus Capital Partners	UK	Seed	7	0
IP Group	UK	Seed	6	1
IQ Capital	UK	Seed	6	0
Earlybird Venture Capital	Germany	Series A	5	1
LocalGlobe	UK	Seed	5	1
Bpifrance	France	Seed	5	1
MetaPlanet	Estonia	Seed	5	0
b2venture	Switzerland	Seed	4	1
UCL Technology Fund	UK	Seed	4	1
Notion Capital	UK	Seed	4	0

Most active growth-stage investors in European Novel AI startups

Investor	Country	Preferred round	Number of rounds	
			2018-2023	2023
Hostplus	Australia	Series B	4	1
M12	USA	Series B	4	1
Cathay Innovation	USA	Series B	3	0
Tencent	China	Series B	3	1
Venture/Science	USA	Series B	3	1
Robert Bosch Venture Capital	Germany	Series B	3	1
Molten Ventures	UK	Series B	3	0
Deutsche Bahn Digital Ventures	Germany	Series B	2	1
Schott AG	Germany	Series B	2	0
Stena Sessan	Sweden	Late VC	2	0

FUTURE OF COMPUTE

DEEP DIVE

EXAMPLES

SEMICONDUCTORS

SUPERCONDUCTORS

PHOTONIC COMPUTING

DISTRIBUTED & DECENTRALISED COMPUTING

RISC V

NEUROMORPHIC COMPUTING

AMBIENT COMPUTING

WEARABLE COMPUTING

IN-MEMORY COMPUTING

BRAIN-COMPUTER INTERFACES

SILICON PHOTONICS

AR / VR / MR

The tools we use to think will continue to evolve

Computing was elegantly summarised by Steve Jobs as a bicycle for the mind.

They are the tools we use, for work or pleasure, to amplify the impact our thoughts can have in the world.

Ultimately, they conserve our most precious resource, our time, and let us do more during our days, our years, and our lifetimes.

Given this deep fundamental value to humanity, 4-out-of-5 of the world's largest companies by market cap have a focus on building the next generation of computing platforms.

Breaking down computing

We can think of computing today as spread across three primary paradigms: *mobile*, *desktop*, and *cloud*.

Within each of these three primary paradigms we can also envisage a tech stack that undergirds them, including the *hardware* (processing, networking, sensors, form factor) and *software* (protocols & standards, operating systems, applications).

Each of these layers of the technology stack, across each of these computing paradigms, is under perpetual change, and some are on the verge of dramatic reinvention as new technologies work their way out of university, institute, and corporate research labs and into new companies.

		Frontend (user facing)		**Backend** (not user facing)	
PARADIGM	**Current**	**Mobile**	**Desktop**	**Cloud**	
	Future	Wearable	Ambient	Centralised Cloud	Decentralised & Distributed Cloud
SOFTWARE	**Applications**	Various			
	Operating Systems	Android, WatchOS, VisionOS, XROS	CoPilot, Alexa, Siri, Google Assist.	Proprietary	Ethereum, Filecoin
	Protocols & Standards	Internet (TCP/IP), Blockchain			
HARDWARE	**Form Factor**	AR/VR/XR, Headphones, BCI, Smart Watches, Smart Contacts	Smart Speakers, TVs, Appliances, Homes, Buildings (integrated)	Datacenters	Existing Edge Devices (see other paradigms)
	Sensors & I/O	Radar, Retinal Scanning, Optical Tracking, Health Sensors			
	Networking	6G Cellular, Satellite Networks, Optical, Peer-to-Peer Direct, Quantum Networks			
	Processing	Semiconductors, Photonics, Neuromorphic, Analog, Quantum			

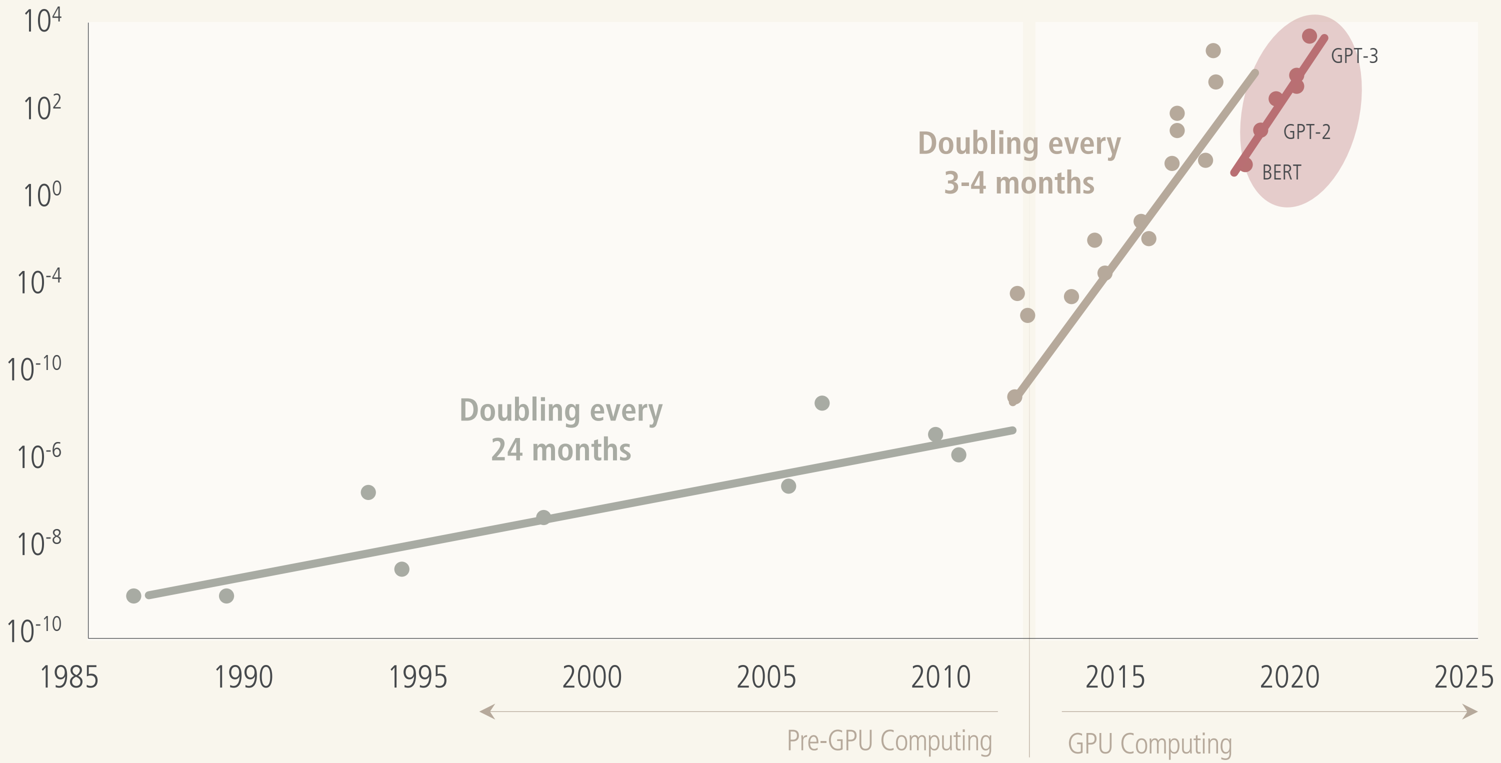
LAKE STAR

(W)C Walden Catalyst

dealroom.co

Computational demand is doubling every 2-3 months…

Computing power demands
Performance in petaFLOP days



LAKE STAR

(W)C Walden Catalyst

dealroom.co

“The data tsunami the world has witnessed over the past decade, combined with the accelerated adoption of AI in consumer and enterprise applications, has created an ever-increasing need for more robust and powerful computing infrastructures, whether in terms of processing, storage, interconnect or workload orchestration.

With AI models getting bigger, Moore’s Law coming to an end, and pressing societal considerations, a paradigm shift is needed in the way this infrastructure is designed, built and operated. This is what the Future of Compute is all about: inventing the architectures and technologies of tomorrow that will continue to drive innovation and bring a new era of prosperity to the masses.

NICOLAS AUTRET

PARTNER AT WALDEN CATALYST

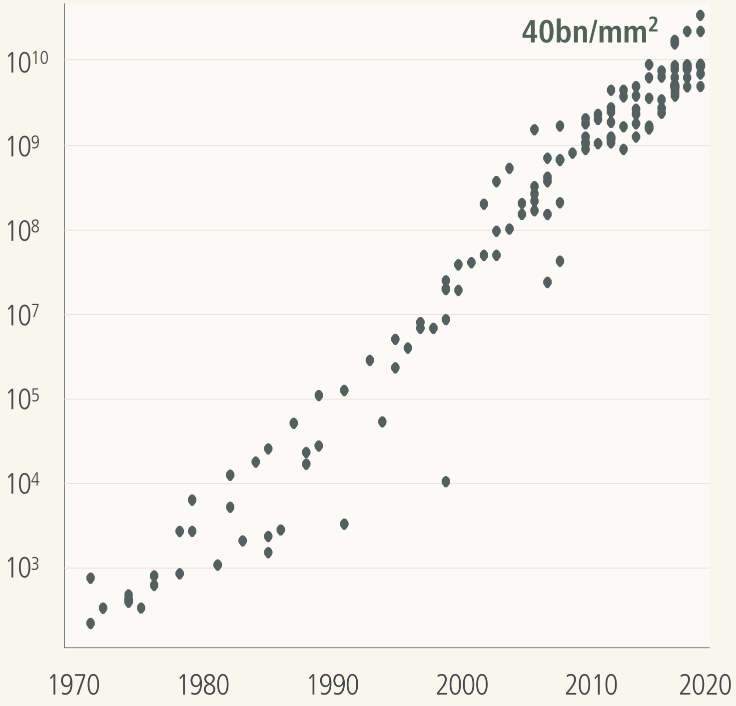
…while computational speed is doubling only every 2 years

We commonly think about how computation doubles and becomes cheaper every year. However, the latest M3 Apple processors using TSMC's 3nm node use transistors that are only 6 atoms wide.

Clearly, we are rapidly approaching the limit of how far we can shrink traditional Si transistors in conventional processors.

New technologies are going to be required to satisfy the rapidly increasing demand.

Moore's Law: the number of transistors on microchips doubles approximately every two years
Transistor count per square millimetre



“ Indeed, the lithography-based shrinking is getting harder and harder, and more and more expensive, such that there are only very few semiconductor fabs that can afford to be in this race to the bottom. But that does not mean that the roadmap will not continue.

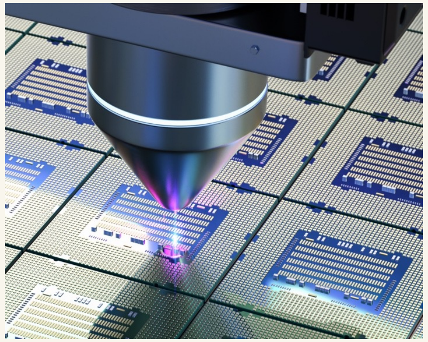
This roadmap will be enabled by advances in lithography, such as high-NA EUV but also new transistor architectures, such as GAA (gate-all-around) devices, CFET transistors or advanced 3D integration.

CYRIL VANČURA
PARTNER AT IMEC.XPAND

LAKE STAR   (W)C Walden Catalyst   dealroom.co

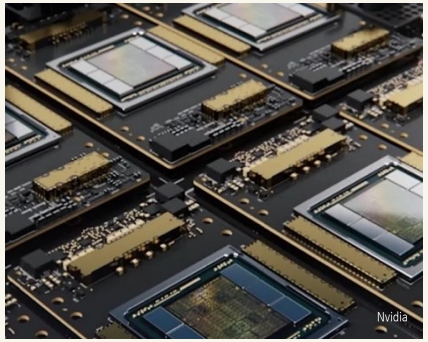
Processing improvements will come from addressing the rate limiting factors

Reduce energy requirements



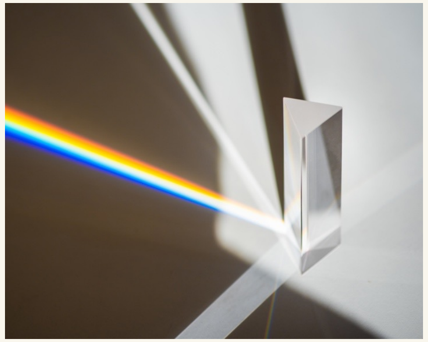
Reducing transistor size, types of operation primitives that can be performed (analog computing, neuromorphic computing).

Address the memory bottleneck



Optimising the movement of data between the memory and the core processing unit is key to improving efficiency, with various ways to achieve this, such as increasing memory bandwidth, compressing memory, and processing-in-memory.

Increase network bandwidth

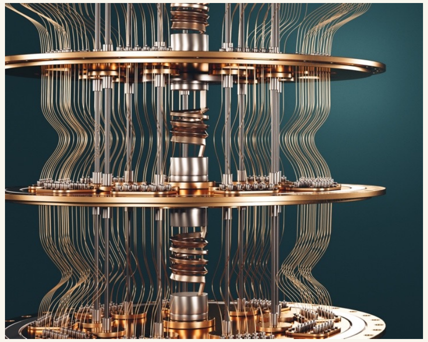


Optical computing and silicon photonics could also bring disruption at the processing or interconnection levels. Photonics have the potential to remove bottleneck on data transmission, particularly in situations where large systems of 100s of servers need to be interconnected to run LLMs.

Alternatives to digital computing

Neuromorphic takes a brain-inspired approach to computing vs. the classical Von Neumann architecture, leveraging sparsity and processing data as it occurs; the promise is a more efficient, low-power, real-time processing, but it requires adapting data pipelines.

A quantum approach



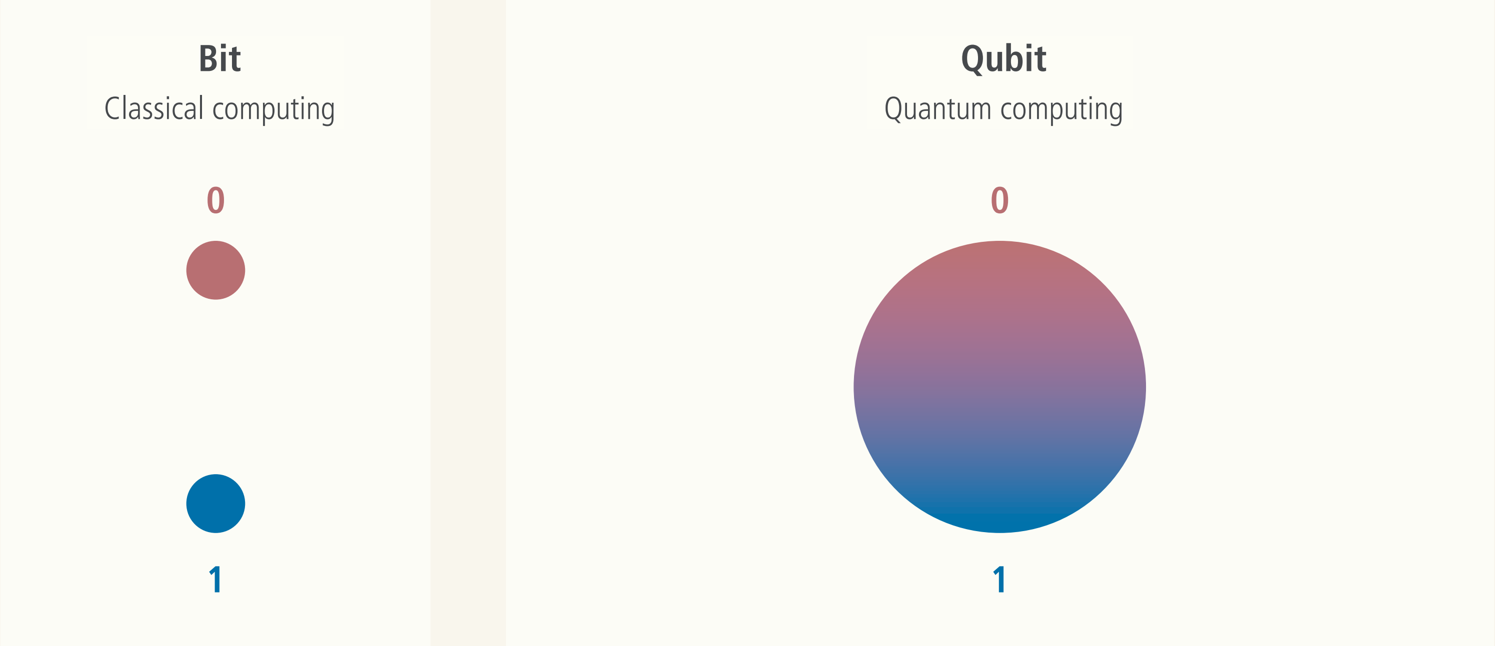
Quantum computing could be a category on its own given its disruptive promise and the level of interest it has received from academia, entrepreneurs and investors; startups and corporates are building various flavours of qubits: superconducting, trapped ions, photonic, neutral atoms, etc.

Quantum computers hold big promises

Traditional computers operate using classical bits, which are limited to binary 0s or 1s, and can't harness parallelism.

Quantum computers leverage the principles of superposition and entanglement, allowing qubits to exist in multiple states simultaneously (0 AND 1 at the same time).

This enables them to perform specific complex calculations in parallel, making them exceptionally efficient for certain tasks like factoring large numbers or searching vast databases.



> "Achieving practical fault-tolerant quantum systems will be a game-changer, enabling longer and more complex quantum computations. In combination with the discovery of new quantum algorithms tailored for specific industries and problems, this will unlock the true potential of quantum computing.
>
> Moreover, the development of quantum communication and networking technologies will pave the way for secure global quantum information exchange, impacting various sectors, including finance and defence.
>
> Lastly, the emergence of quantum AI (QAI) will unleash more creative, sustainable, and powerful foundational models propelling us forward.

MARKUS PFLITSCH

FOUNDER & CEO
TERRA QUANTUM

Quantum Computing takes a dramatically new approach

In addition to innovative improvements to traditional semiconductor physics, novel processing approaches using quantum mechanical phenomena have demonstrated significant improvements in solving certain types of problems.

"Our roadmap is one of the most aggressive out there and we are aiming at reaching performance levels that beat traditional computing by end of 2028. I think it's fair to assume it will be reached by several players by 2030.

The first industry to be impacted will be fundamental physics research, followed by material science and chemistry innovation, and then broader simulation.

Europe has best in class talent and capital efficiency but limited access to private capital and to Big Tech companies.

THÉAU PERONNIN

CO-FOUNDER OF ALICE & BOB

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Wearable computing is the future form factor of mobile computing

Mobile computing, which today is dominated by phones and tablets, is making the transition to wearable computing such as smartwatches, smart glasses/contacts, and headphones that you can control with your speech, movements, or thoughts.

Since saving people time is the ultimate goal for computers, increasing the speed with which the computer can understand your intention and deliver to you the feedback you need, the more effective it is at its job.

While endless ethical and legal questions can be asked of such technologies and how they are allowed to operate, their eventual existence seems inevitable.

LAKE STAR

(W)C Walden Catalyst

dealroom.co

AR / VR / XR / MR

Meta is currently the dominant player in this category with both the Quest headset and Ray-Ban smart glasses. Apple announced its entry next year with the Apple Vision Pro headset.

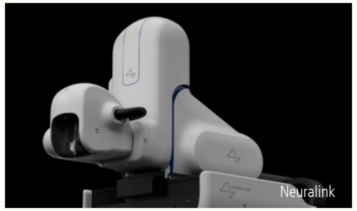
Headphones

Big Tech handset manufacturers have been expanding steadily into this segment with Apple Airpods, Google Pixel Buds, and Samsung Galaxy Buds.

Smartwatches

Apple Watch continues to dominate while Google's Fitbit acquisition aims to build a competitive offering. Samsung continues to invest as well.

Brain-Computer Interfaces (BCIs)



Brain-Computer Interface (BCI) companies continue to progress but remain far away from a commercially viable product.

Other

New form factors are starting to be experimented with such as the Humane smart pin.

Ambient computing will replace desktop computing

Desktop computing, including laptops and smart TVs, is making the shift to ambient computing.

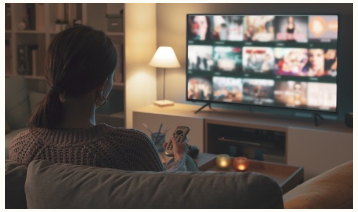
Ambient computing can be characterised as a shift away from devices you use while stationary that are just yours, to embedding computing into the spaces we live our lives including our homes, workplaces, transportation, social spaces, and commercial locations.

The way people will engage with these tools in a fully ambient computing context will be multi-modal, taking advantage of historical input/output methods such as keyboards, remotes, screens, and speakers, while also integrating new interaction modes such as voice, gesture, facial expression, and object detection.

Desktop/Laptop Computers

Desktop and laptop computers will shift from personal computers (PCs) to stateless computers that multiple users can log into and securely access their unique environment.

Smart TVs/Displays



People will be able to securely access all of their content and files directly from any screen leveraging a variety of input modalities.

Smart Speakers

Speakers such as Apple HomePod, Google Home, Amazon Echo, Meta Portal, and Zoom Meeting Rooms, will go from being independent devices to fully integrated nodes in a holistic ambient system.

Smart Cars

Cars will increasingly define a key "third space" battle ground where Big Tech (Apple CarPlay and Android Auto) compete with car brands like Tesla for the front-end user engagement experience as people travel. This will accelerate as autonomous driving goes mainstream.

Smart Appliances

As connectivity and edge intelligence penetrates deeper into small devices, fridges, toasters, doors, and windows will start to look and feel like extensions of a central ambient experience instead of disconnected single function products.

Cloud computing is bifurcating into a centralised and decentralised cloud

Cloud computing such as AWS, GCP, and Azure is undergoing a bifurcation into centralised and decentralised/distributed cloud computing.

While we fully expect centralised cloud providers such as the hyperscalers stated above to continue to provide a centrally managed solution, where they control the resource allocation internally, we also are seeing new technologies emerge that provide credible alternatives using hardware that is not owned wholly by a company.

Concretely, we expect that companies and individuals will be able to store files and run computing workloads on other people's devices via an operating system and infra-structure that manages resource allocation, privacy, security, and compensation for those lending their device to the network for use.

Example use cases for this would be a college student rendering a video on other students' laptops while they sleep instead of paying AWS, or a company training a ML model on other company hardware when not in primary use instead of using Azure.

While big tech companies will likely offer this capability to users of their hardware, we also believe a novel approach that is hardware agnostic can benefit from a wider pool of compute resources to offer superior performance.

Blockchain technologies start to explore how these types of tools could look, and we expect continued innovation in protocols here.

The battle for the Operating System of the future has started

“ As shifts in computing come increasingly into view, Big Tech companies have started to fund large organisations to the tune of billions of dollars to develop next gen OSs that disrupt the current hegemony. For hardware manufacturers like Apple and Samsung there is the promise of a mega upgrade cycle. For advertising platforms like Google and Facebook there is the ability to set the rules and avoid disintermediation. For retailers like Amazon and Alibaba there is the advantage of capturing additional spend through convenient integrations. Most importantly, however, controlling the operating system means the ability to tax companies and users that live and work on their platforms. Given the amount of value that is created and exchanged digitally, this presents a multi-trillion-dollar opportunity.

But…

Historically, much of the innovation that has become a winning computing platform was acquired in from research labs and startup companies. The Graphical User Interface was invented at Xerox PARC, the computer mouse was invented at Stanford Research Institute, and Android was a startup in Silicon Valley. This presents an exciting opportunity for startups that develop novel computing form factors and operating systems people love.
If they have the ability to operate independently from the existing platforms and can avoid acquisition as they scale, they stand to become a trillion-dollar Big Tech platform in the new paradigm.

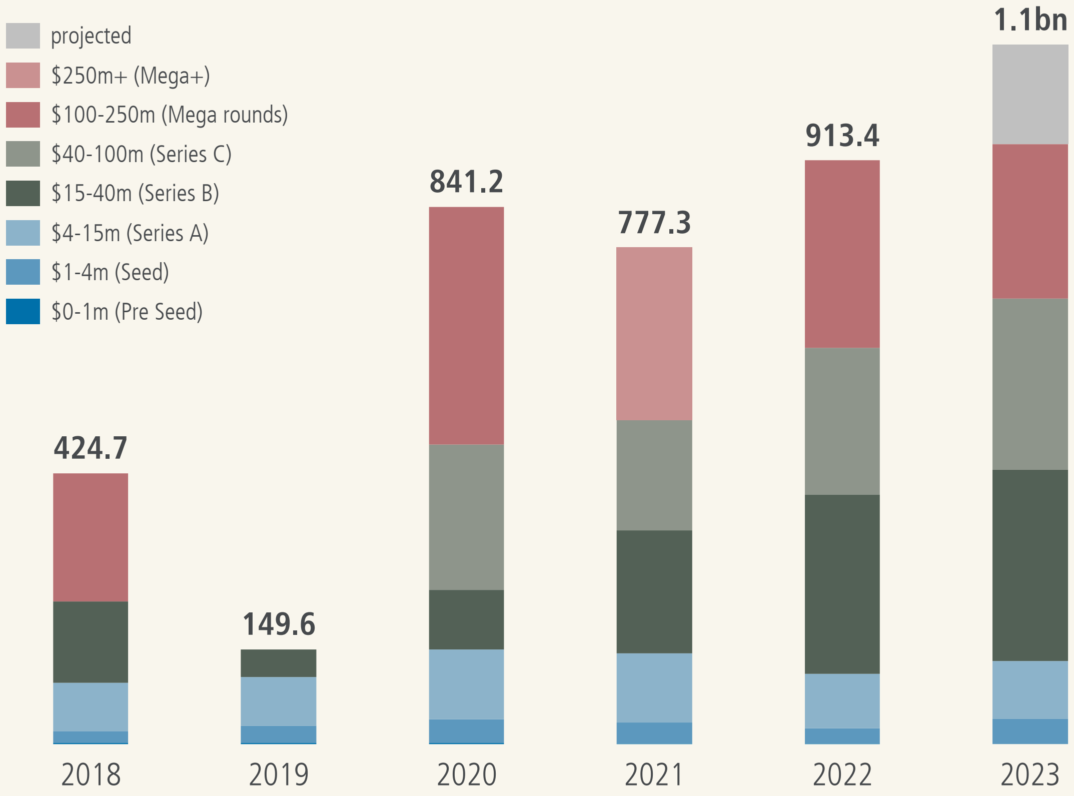
STEVEN JACOBS

PARTNER & CPO AT LAKESTAR

Investment in Future of Computing reached record levels in 2023 led mainly by quantum computers, AR/VR hardware and AI chips

VC investment in European Future of Computing startups

$ m



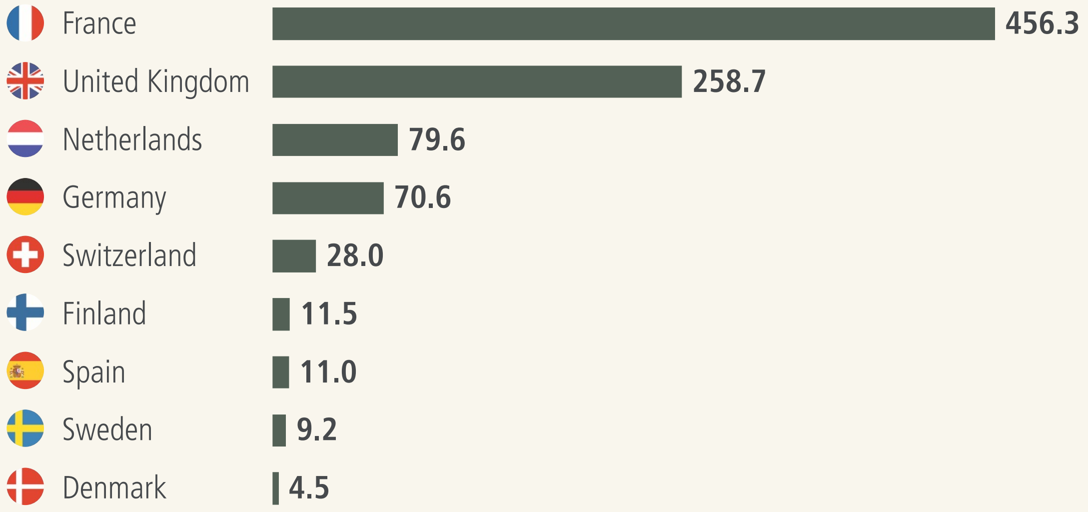
Notable Deep Tech rounds in Future of Computing in 2023

Startup	Funding round	Focus
Aledia	€120m Series D	AR/VR hardware
PASQAL	€100m Series B	Quantum computers
SIPEARL	€90m Series A	Advanced AI chips
QUANTUM MOTION	£42m Series B	Quantum computers
QUANDELA	€50m Series B	Quantum computers
gensyn	$34m Series A	Distributed computing

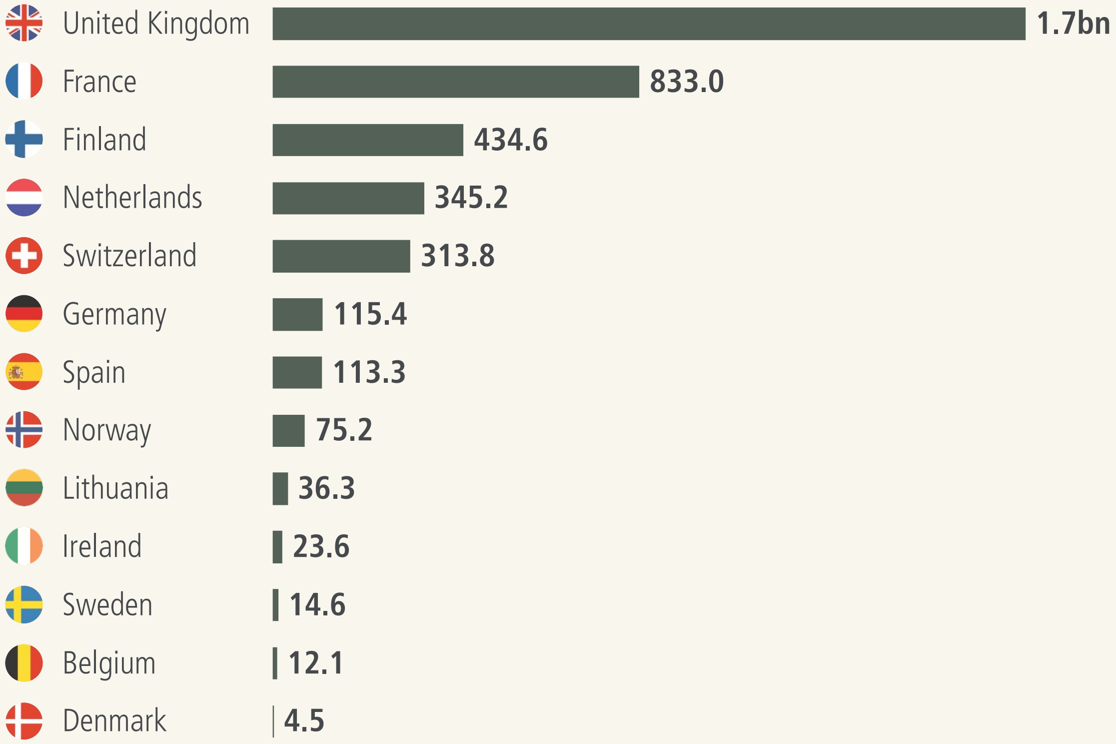
LAKE STAR (W)C Walden Catalyst dealroom.co

France and UK lead the Future of Compute funding landscape

VC investment in Future of Computing startups by country, 2023
$ m

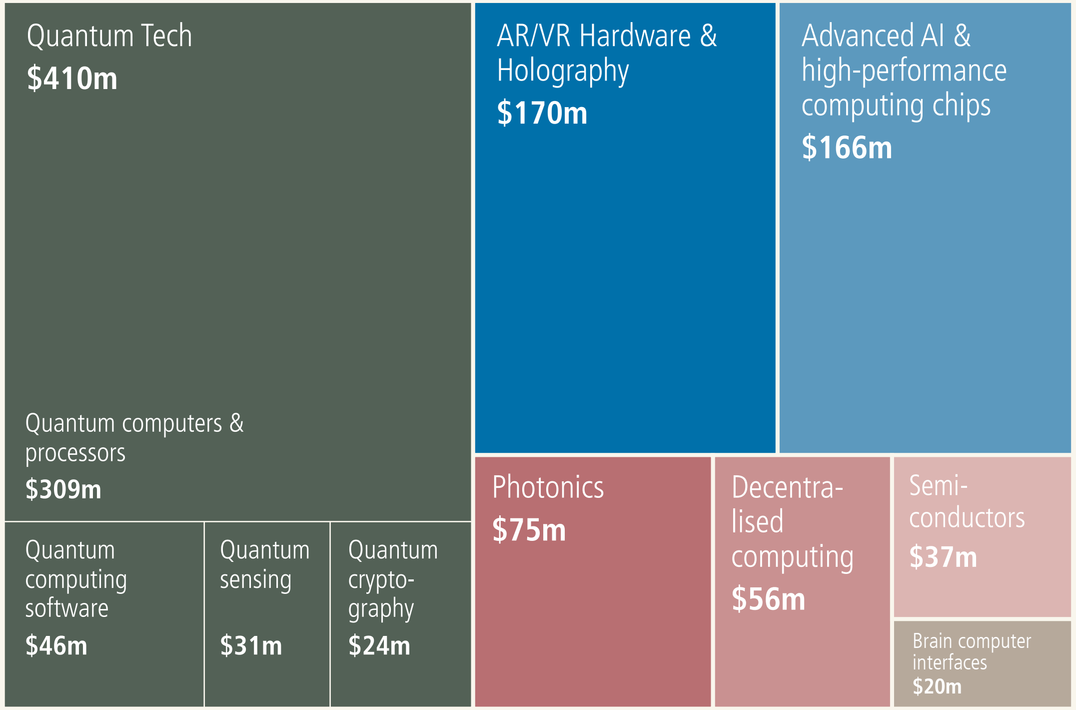


VC investment in Future of Computing startups by country, 2018-2023
$ m

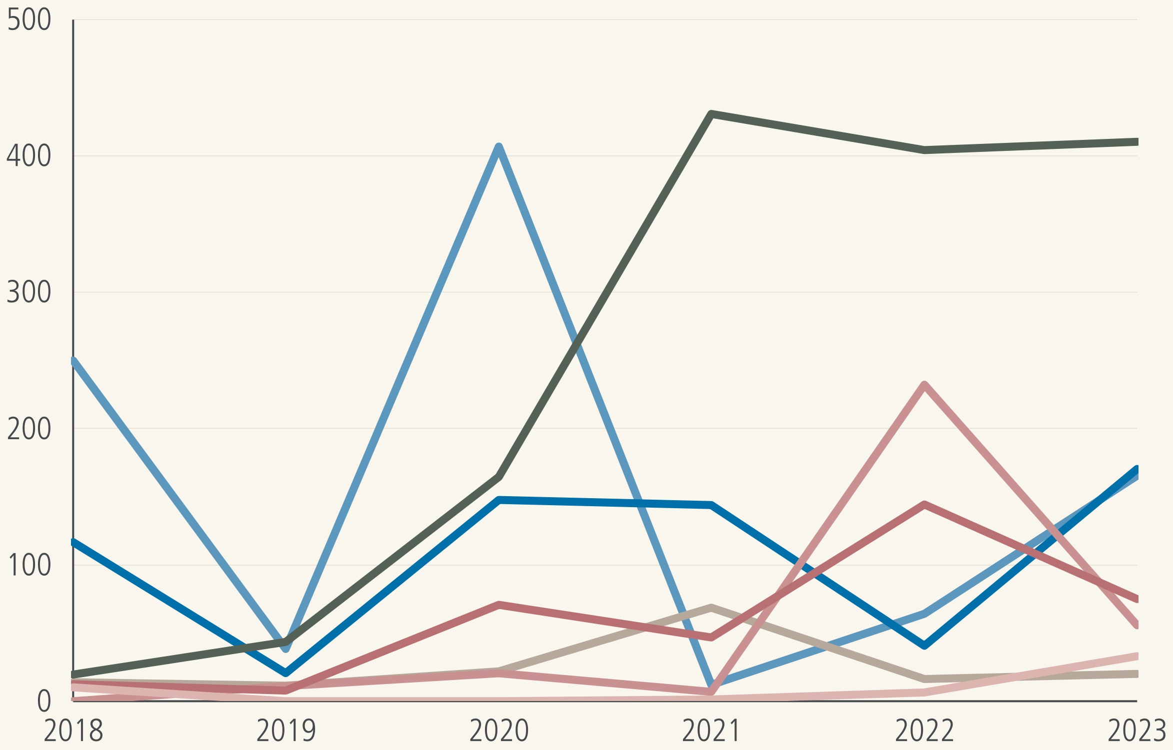


Quantum Tech, in particular hardware, received most funding in 2023, followed by AR/VR hardware and Advanced AI chips

European Future of Compute funding by segment, 2023
$ m



European Future of Compute funding by segment, 2018-2023
$ m



LAKE STAR

(W)C Walden Catalyst

dealroom.co

Mix of specialised and generalists funds are active in Future of Compute

Most active early-stage investors European in Future of Compute startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
EIC Fund (European Innovation Council Fund)		Early VC	25	6
Quantonation		Seed	18	4
Bpifrance		Seed	17	6
Oxford Science Enterprises		Seed	13	3
High-Tech Gründerfonds		Seed	12	1
Verve Ventures		Series A	11	3
Amadeus Capital Partners		Seed	10	3
Supernova Invest		Early VC	10	2
Voima Ventures		Seed	8	2
Innovation Industries		Series A	7	2

Most active growth-stage investors in European Future of Compute startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Molten Ventures		Series B	6	1
Robert Bosch Venture Capital		Series B	5	1
Invest-NL		Late VC	4	1
Tencent		Series B	4	0
British Patient Capital (BPC)		Series B	3	1
Braemar Energy Ventures		Series B	3	1
Swisscom Ventures		Series C	3	1
Western Digital Capital		Series B	3	1
Intel Capital		Series B	3	0
Lansdowne Partners		Series B	2	1

SPACE TECH

DEEP DIVE

EXAMPLES

GROUND INFRASTRUCTURE

SPACECRAFT PARTS & PAYLOADS

PROPULSION SYSTEMS

SATELLITE MANUFACTURING & PLATFORMS

LAUNCH VEHICLES

STRATOSPHERIC BALLOONS

SPACEPLANES & HYPERSONIC PLANES

IN-ORBIT SERVICING

SPACE DEBRIS & MISSION PLANNING

IN-SPACE MANUFACTURING & TRANSPORTATION

SPACE STATIONS & TOURISM

SPACE MINING

MOON & MARS ECONOMY

EARTH OBSERVATION

COMMUNICATION / CONNECTIVITY

NAVIGATION

Sovereignty and decreasing launch cost have led to a new wave of Space Tech

History of Space Exploration

The exploration of space began as a product of intense competition between global powers, initially fuelled by political, societal, and economic rivalries. The iconic launch of Sputnik by the Soviet Union triggered the United States' ambitious Apollo program, which reached its pinnacle with the historic moon landing in 1969 by Neil Armstrong.

However, this era of triumph was short-lived, as the Apollo program was swiftly suspended merely three years after the momentous lunar landing. The high costs and risks associated with space exploration led to a period dubbed the "space winter." It would take nearly five decades for humanity to rekindle its lunar aspirations, culminating in the Artemis missions.

Today's Space Landscape

What was once primarily a realm dominated by governments has evolved into a diverse ecosystem. New participants such as India, China, various Arab states, and private enterprises like SpaceX, Amazon, and OneWeb have entered the scene, indicating a burgeoning landscape of opportunities. Europe's role in this new era hinges on leveraging its unique strengths to make significant contributions.

In the contemporary space realm, two pivotal trends are reshaping the landscape. Firstly, SpaceX's pioneering efforts in developing reusable rockets, notably illustrated by the successful landings of the Falcon 9 rockets in 2015, have dramatically altered the economics of space travel. Launch costs have plummeted from $50,000 per kilogram during the space shuttle era to $5,000 per kilogram, with further 10x reductions expected with the advent of Starship.

Secondly, governments across the globe are recognising the geopolitical importance of space access and the diverse utilities of space assets. These assets now serve critical roles beyond defence, encompassing climate change monitoring, wildfire and water management, as well as global asset tracking.

Future Outlook

Looking ahead, the future of space exploration is poised for transformative changes. The limitations imposed by mass on business models are on the brink of resolution with the introduction of super heavy launchers like Starship. This shift is expected to move the focus from miniaturisation towards constructing larger, more easily manufacturable infrastructures such as super large satellite classes and private space stations.

However, space is still a young industry facing many supply chain challenges. Many companies will work on making supply chains not only faster but also more resilient.

Anticipated in the future trajectory is the rise of regional champions, highlighting the significance of sovereignty in the space domain. This signifies a shift in the dynamics of space exploration, transforming it from an exclusive field accessible only to a select few to an arena open to a broader spectrum of players, each contributing to the expanding frontier of human endeavours beyond Earth.

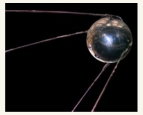
Space was historically dominated by two governments. However, many new players are entering the field – from national governments to private players

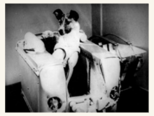
SPACEX | BLUE ORIGIN | isar aerospace | AXIOM SPACE | RFA Rocket Factory | SPACEX

1960s | 1970s | 1980s | 1990s | 2000s | 2010s | 2020s | 2030s

1957
Sputnik I
1st man-made object in space

Sputnik II
1st living-being in space (dog "Laika")





1959
Luna II
1st man-made object on the moon

1961
Yuri Gagarin
1st man in space

1969
Neil Armstrong
1st man on the moon

1981
Space Shuttle
Start of Space Shuttle Program

1998
ISS
Largest cross-country collaboration

2015
Falcon 9 Return
1st re-usable rocket

2021
Private sub-orbital flight
Jeff Bezoz and Blue Origin make 1st successful sub-orbital flight

2022
Space Station Tiangong
China launches final module

2023
Moon's south polar
India successfully lands rover on the south polar region of the moon

2024
NASA Artemis mission

Further private launch companies come online

2025
1st Taikonauts on the moon (China)

2026
First private company on the moon (SpaceX)

First private space stations (Axiom)

The influence of space technology on our daily lives is already enormous and is anticipated to grow further with many new exciting use cases

Communications

Internet connectivity and television broadcasting, powered by space-based satellites, enable global communication, ensuring seamless access to information and entertainment across the world.

Navigation

GNSS technology (e.g., GPS and Galileo) integrated into various devices facilitates precise location tracking, enhancing daily activities such as driving, finding directions, and utilising ride-sharing apps, ensuring efficient and accurate navigation.

Earth Observation

Weather satellites provide vital data for predicting and monitoring weather patterns, offering early warnings for natural disasters. It aids in agricultural planning, assessing crop health, managing water resources, and monitoring environmental shifts.

Future Use Cases

Space technology's future potential spans diverse fields such as asteroid mining, in-space manufacturing of organs, and semiconductors, offering innovative opportunities to revolutionise industries and address various challenges on Earth.

LAKE STAR

(W)C Walden Catalyst

dealroom.co

> "Europe grapples with societal, economic, and security challenges. Space holds vast potential to address these and future crises, fuel job creation, and drive innovation in the European space industry.
>
> With a substantial allocation of €1.3bn over three years, ESA is engaging with the commercial space sector in the New Space context in three main roles: Enabler, Partner & Customer.
>
> Collaborating with European and national partners, ESA aspires to position Europe as a hub for space commercialisation, nurturing global space companies aligned with future goals.

GIANLUIGI BALDESI

HEAD OF THE VENTURES AND FINANCING OFFICE AT ESA

Moreover, governments have realised, Space is the new frontier and a crucial infrastructure technology

Satellite images documenting 64km convoy of military vehicles moving into Ukraine

Ukraine turning to Elon Musk and Starlink as Russian forces have taken down ground-based internet

“The EU is shifting towards self-reliance in space capabilities due to geopolitical changes, with a long-term commitment from European governments to build national space capabilities.

New constellations of satellites are building a breath-taking pace, developing what we consider to be a new digital infrastructure in the sky. This is like the advent of a new internet, a new road network, a new railway network – hugely impactful. Beyond the new communication capability of Starlink and OneWeb, satellites are also observing the earth, auditing activities in high resolution at close to real time. With a broad range of sensor modalities petabytes of data are being collected each day about the planet. AI/ML then provides insights to identify anomalies, use resources more efficiently, or to hold bad actors to account. The EU recognises the strategic value and has unleashed a broad range of initiatives to support European Venture backed businesses address this trillion-dollar market opportunity.

MARK BOGGETT

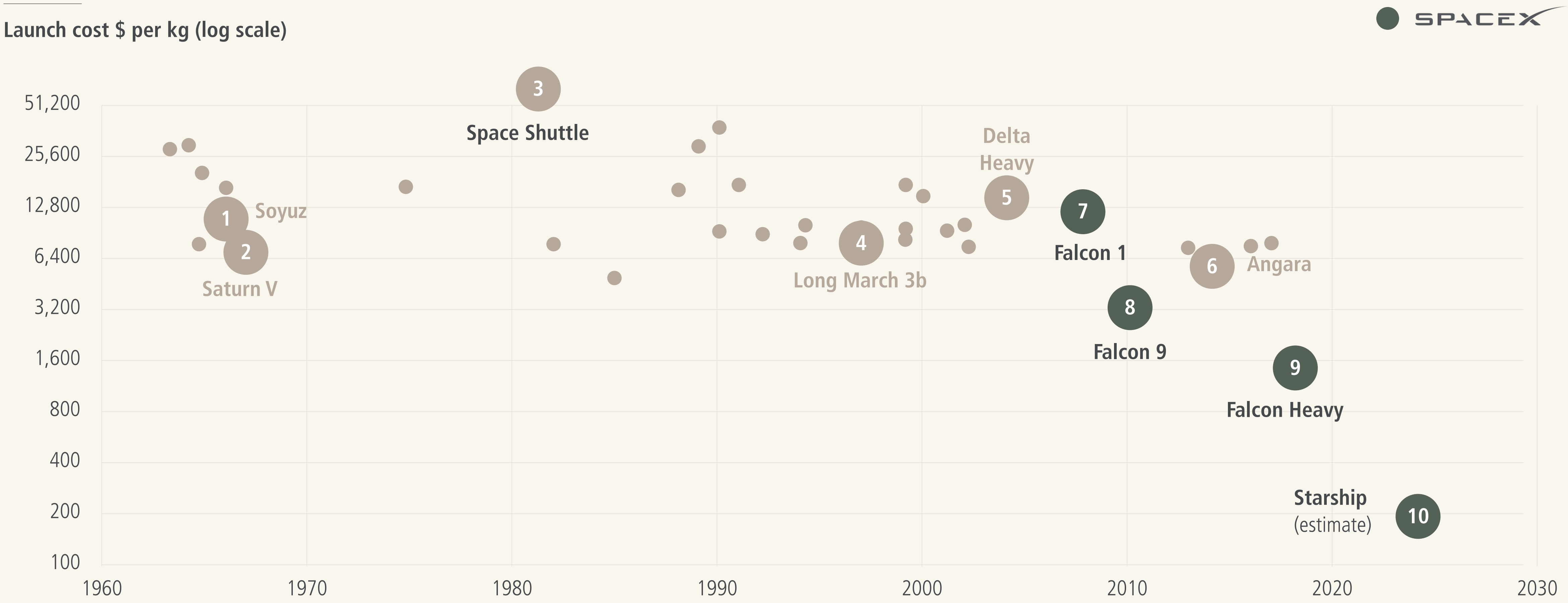
CEO AT SERAPHIM SPACE FUND

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Rapidly decreasing launch costs create fundamentally new business opportunities



LAKE STAR

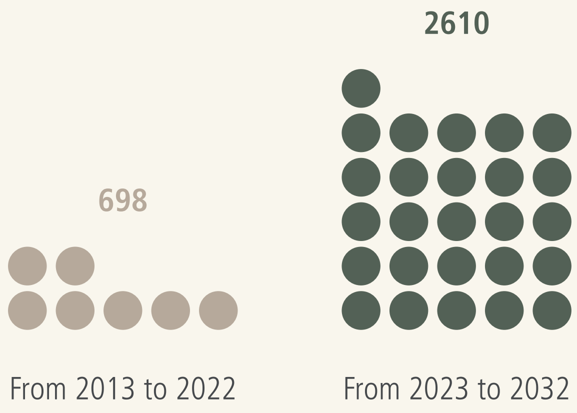
(W)C Walden Catalyst

dealroom.co

The decrease in launch costs will lead to a wave of satellite launches and unlock completely new business models

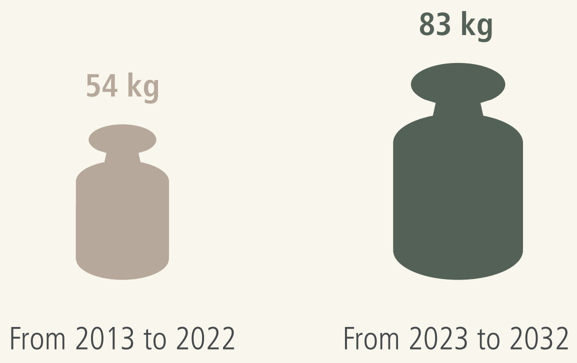
As launch capacity comes online, a new wave of satellite launches is expected

Average number of Smallsats (<500kg) launched per year



With decreasing launch cost per kg, satellite buses are expected to grow in size

Average launch mass per satellite



Source: euroconsult-ec.com

> “Access to space stands as a pivotal infrastructure technology, essential for upholding a region’s sovereignty.
>
> In Europe, a parallel pattern emerges akin to the United States, where governments serve as the primary customers, while private enterprises act as the providers of launch services.
>
> With national governments aiming to maintain authority over their assets and launch timetables, the significance of national launch providers continues to ascend.
>
> Furthermore, as Starship focuses on accommodating super heavy payloads, Isar Aerospace zeroes in on catering to small to medium-sized satellites and constellations—representing the bulk of the market.

DANIEL METZLER

CEO AT ISAR AEROSPACE

LAKE STAR

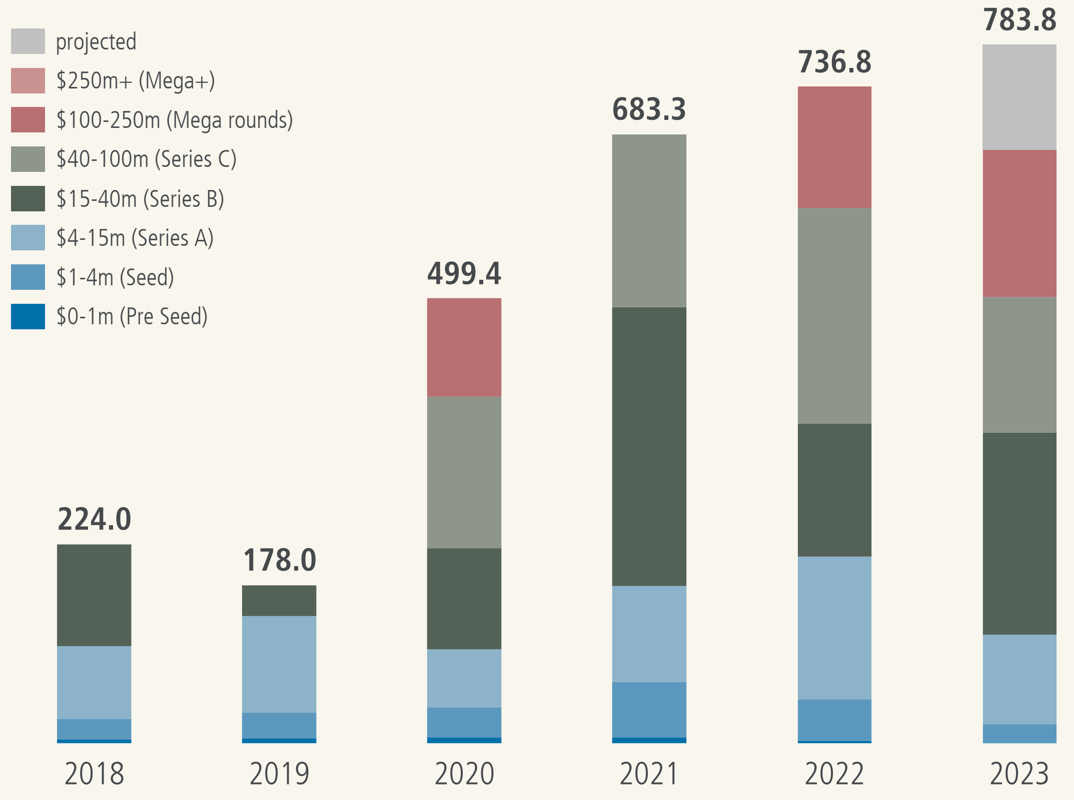
(W)C Walden Catalyst

dealroom.co

Strong funding activity with a focus on launch and in-space services

VC investment in European Space Tech startups

$ m

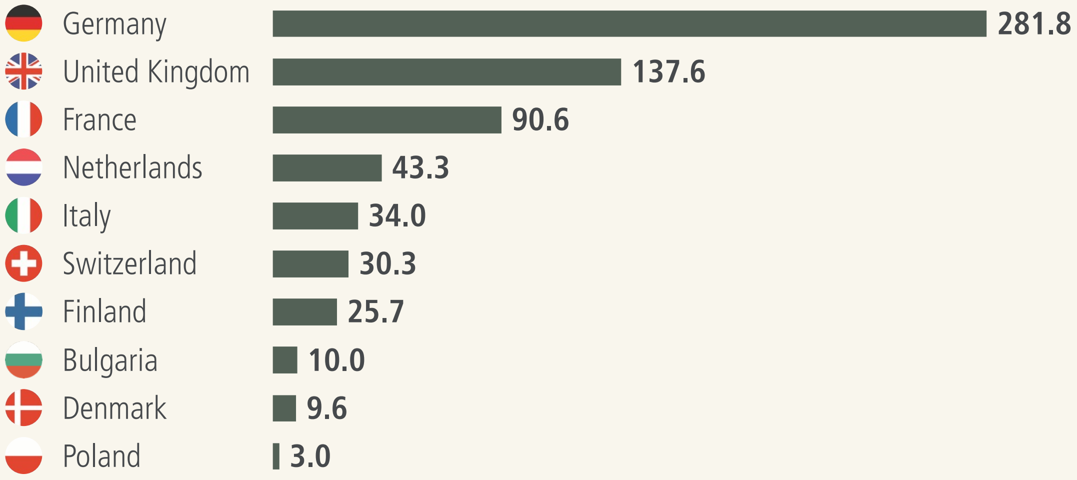


Notable Deep Tech rounds in Space Tech in 2023

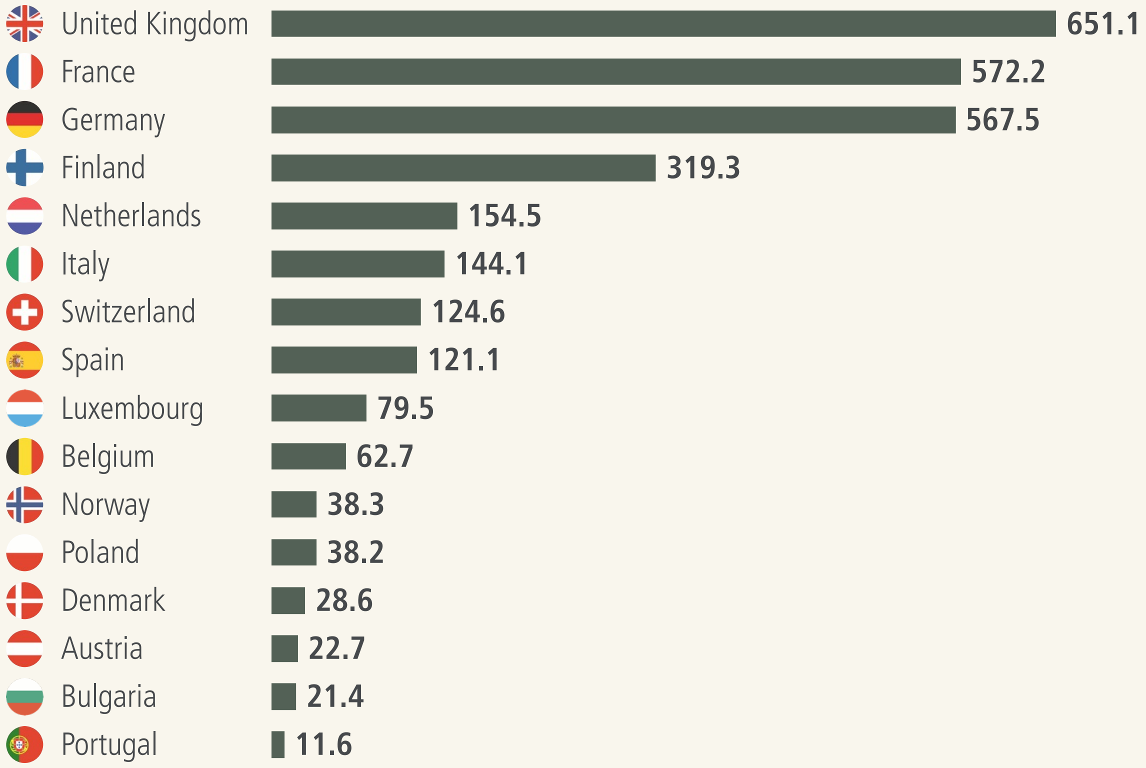
Startup	Funding round	Focus
isar aerospace	$165m Series C	Launch vehicles
exotrail	$58m Series C	In-space transportation
OPEN COSMOS	$50m Series B	End-to-end satellite manufacturing and operations
The Exploration Company	€40m Series A	Space resource exploration
RFA Rocket Factory	€30m Convertible	Launch vehicles
clearspace today	€27m Series A	Space debris removal

Germany received the most VC funding in 2023, followed by UK and France. Since 2018, UK, France and Germany have attracted a similar level of investment

VC investment in European Space Tech startups by country, 2023
$ m



VC investment in European Space Tech startups by country, 2018-2023
$ m

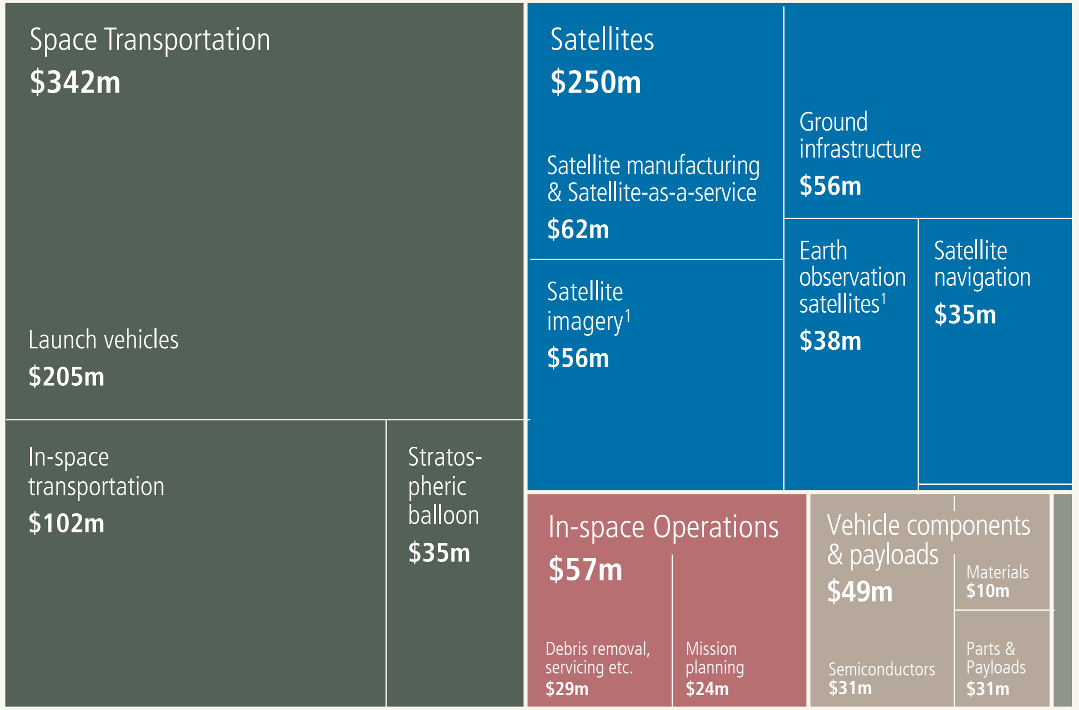


LAKE STAR (W)C Walden Catalyst dealroom.co

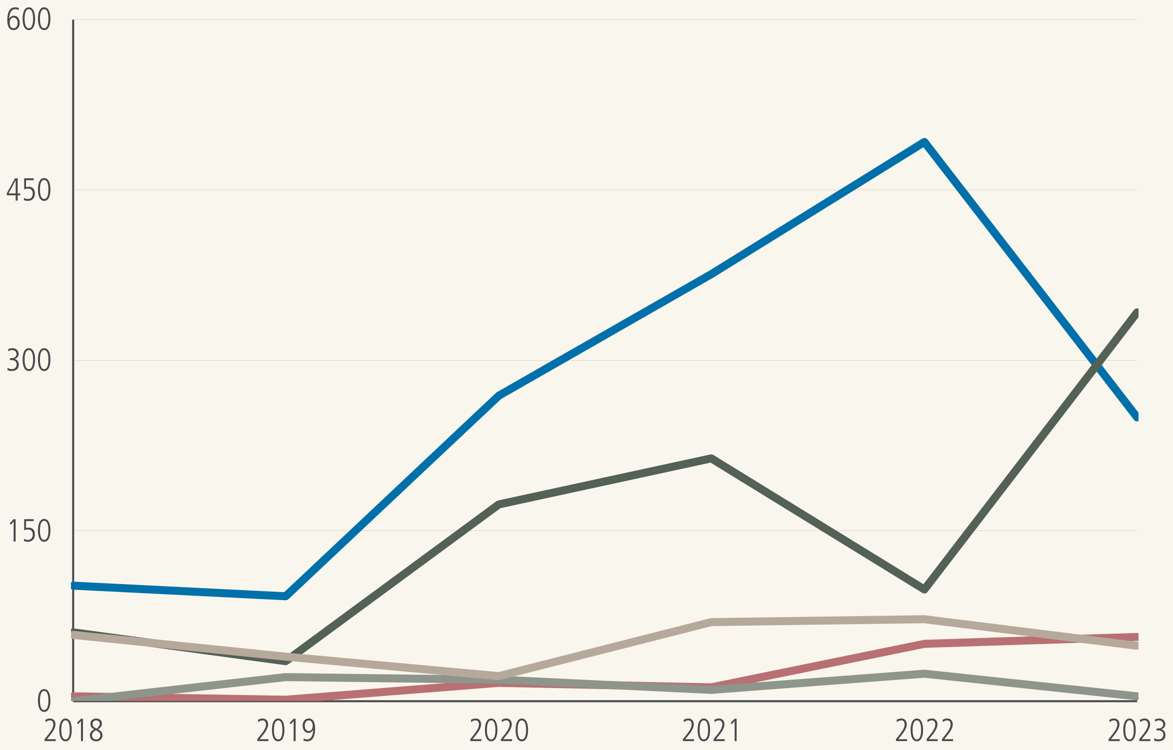
Notably excluding OneWeb, given recent M&A.

Space Tech has seen a rise in space transportation financing, while satellites saw a decline in funding in 2023

European Space Tech funding by segment, 2023
$ m



European Space Tech funding by segment, 2018-2023
$ m



1. Earth observation satellites include startups having their proprietary satellite observation constellation, while satellite imagery startups focus only on the analysis of the data. Notably excluding OneWeb, given recent M&A.

Space Tech attracts funding beyond dedicated VCs

	Core Space Tech investors[1]	VCs active in Space Tech, both Downstream and Upstream (excl. core Space Tech[1])
Series B+	NewSpace Capital, Satlease Capital, Tikehau Ace Capital	BGF, Move Capital, Molten, MIG Capital, Eurazeo, Digital+ Partners, Neva SGR
Series A	Alpine Space Ventures, Space Ventures Investors, space·tec capital, Seraphim, promusventures, otb	Kibo Ventures, Supernova Invest, Earlybird, Lake Star, partech, Omnes, Demeter, MMC, Verve Ventures, octopus ventures, HV Capital, Future Planet Capital
Seed	Primo Space, vsquared ventures, Karista, RYMD Kapital, promusventures, Space Ventures, Expansion Aerospace Ventures	Bayern Kapital, Amadeus Capital Partners, bpifrance, 360 Capital, LVC Partners, 7percent Ventures, High-Tech Gründerfonds, Speedinvest, IQ Capital, eXpon Capital, cdp, Apex Ventures
Pre-Seed Accelerators & incubators	Parsec Accelerator, Space Founders, space3ac, Takeoff, Astropreneurs, Starburst, Space Camp Accelerator	Rockstart, The Faktory Fund, imec, Sting, lead, Deeptech Labs

1. Core space tech investors refers to VCs & accelerators with at least one fund with Space Tech as main investment focus.
The investors are ranked based on several parameters: total number of rounds & amount invested in Space Tech Upstream and Downstream in Europe. Investors reviewed: only VCs and accelerators; the geography of investors is the same as the geography of the startups: Europe. Promus Ventures is counted as both the US and European VC due to its significant presence in Europe (its venture fund Orbital Ventures is anchored in Luxembourg and is backed by EIF, Luxembourg Government and SNCI).

Dedicated space funds at early stage; generalist funds at later stages

Most active early-stage investors in European Space Tech startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Seraphim Space		Seed	38	3
Bpifrance		Seed	29	2
EIC Fund (European Innovation Council Fund)		Early VC	27	0
High-Tech Gründerfonds		Seed	25	1
Fondation FIT		Seed	19	0
IQ Capital		Seed	16	2
Bayern Kapital		Seed	13	2
UVC Partners		Seed	13	1
Verve Ventures		Series A	13	0
Primo Ventures		Seed	12	2

Most active growth-stage investors in European Space Tech startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Molten Ventures		Series B	7	1
Eurazeo		Series B	3	1
Sepides		Late VC	3	0
NewSpace Capital		Series C	3	0
Swisscom Ventures		Series C	2	2
B Capital Group		Series B	2	1
The Luxembourg Future Fund		Series C	2	1
Arcano		Series B	2	0
The Firmament Group		Growth Equity VC	2	0
Definvest		Series B	2	0

NOVEL ENERGY

DEEP DIVE

EXAMPLES

SPACE-BASED SOLAR

NUCLEAR FUSION

NUCLEAR FISSION

NEXT GEN SOLAR

GEOTHERMAL

SUPER/ULTRACAPACITORS

FLYWHEELS

NEW CELL CHEMISTRIES

(GREEN) HYDROGEN

LONG-DURATION STORAGE

HYDROGEN/ELECTRIC AVIATION

WASTE HEAT RECOVERY

The changing energy landscape poses unprecedented challenges, but also huge market opportunities

Addressing the energy challenges

Renewables like wind, solar, hydro, and biomass are rising, but Europe still relies heavily on coal, oil, and gas (over 60% in 2020). New energy methods are essential for decarbonisation and unlinking economic growth from CO_2.

Europe's renewable energy in public net production has grown from 28% in 2015 to 43% in 2023, yet poses grid challenges due to increased volatility, requiring diverse energy storage systems.

Shifting to renewables demands more flexible energy infrastructure with increased cross-border flows and adaptable and quick-to-ramp-up power generation to meet peak energy demands.

The growing adoption of AI is expected to lead to a substantial rise in global electricity consumption, reaching an annual range of 85 to 134 TWh by 2027. This quantity is comparable to the electricity usage of entire countries such as the Netherlands.

In addition, higher energy prices, strengthened climate policies, and schemes like the Inflation Reduction Act, REPowerEU, and the Fit for 55 package shape future energy markets.

New scientific and engineering breakthroughs are needed across the entire energy value chain:

Evolution in Energy Generation

Advancements in energy generation encompass Fission 2.0 (e.g., advanced modular reactors), breakthroughs in photovoltaics, or geothermal solutions. Additionally, much earlier-stage technologies involve nuclear fusion and in-space solar power.

Advancements in Energy Storage

Energy storage advancements are crucial, addressing a wide spectrum of needs, from storing kWh to GWh and spanning short-duration to long-duration requirements. These solutions encompass supercapacitors, flywheels, novel battery cell chemistries, and long-term energy storage systems involving hydrogen.

Transforming Energy Transportation

The realm of innovation includes the establishment of a green hydrogen infrastructure and the exploration of unconventional energy transmission methods, such as space-based solar power transmitted via microwaves or lasers.

Utilisation Innovations

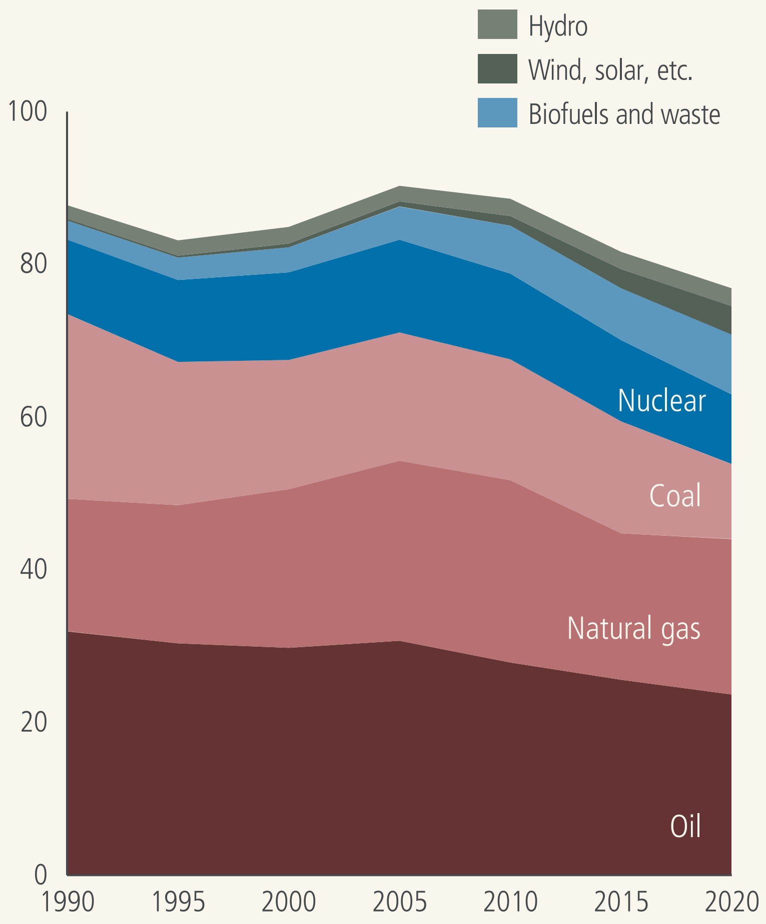
Innovations within the energy value chain will unlock new applications, like electric vehicles (EVs) with ranges exceeding 1000 kilometres or more, and advancements for eAviation. Furthermore, novel solutions are needed to decarbonise industries like steel, utilising hydrogen, sodium, or electricity, as well as addressing the challenges in the cement industry.

New forms of energy generation are needed to replace fossil fuels and further decouple growth from CO_2 emission

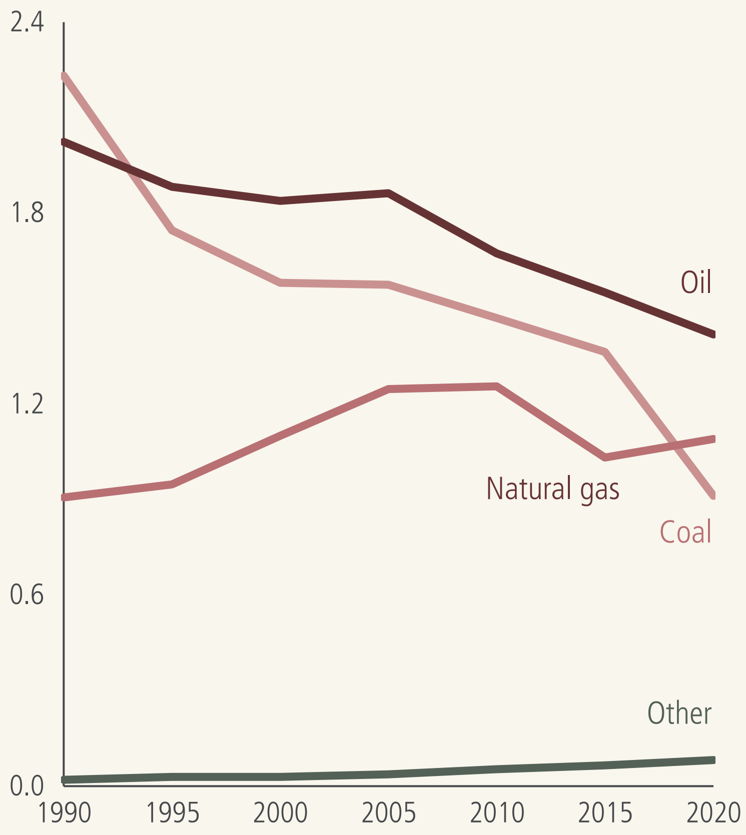
Despite the consistent growth in the proportion of renewable energy provided by wind, solar, hydro, and biomass, Europe's overall energy supply continues to heavily rely on coal, oil, and natural gas, accounting for more than 60% of the total energy supply in 2020.

Additional types and origins of energy are necessary to continue decreasing CO_2 emissions. Encouraging advancements and cost efficiencies in the production of green hydrogen and advanced nuclear fission 2.0 could offer solutions.

Total energy supply (TES) by source, Europe 1990-2020
TJ million



CO_2 emissions by energy source, Europe 1990-2020
Mt CO_2



LAKE STAR
(W)C Walden Catalyst
dealroom.co

Source: IEA World Energy Balances 2022 https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances
IEA Greenhouse Gas Emissions from Energy https://www.iea.org/data-and-statistics/data-product/co2-emissions-from-fuel-combustion

Nuclear fusion holds many promises but still faces engineering challenges to be commercially available

The energy released through nuclear fusion is what powers stars, including our Sun.

The idea of generating energy from a fusion power plant originated back in the early 1950s. Since then, the fusion industry has steadily progressed towards achieving net energy gain.

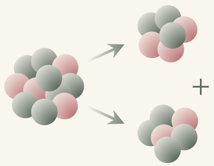
Two main technological approaches have been pursued: *Magnetic Confinement Fusion Energy* (MFE) with tokamak and stellarator technology, and *Inertial Fusion Energy* (IFE) with laser technology or other short and intense energy sources.

LAKE STAR

(W)^C Walden Catalyst

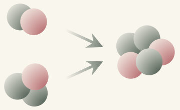
dealroom.co

Nuclear fission


+ Energy

Nuclear fission is a process in which the nucleus of an atom is split into smaller nuclei, releasing a significant amount of energy. The major downsides are the radioactive byproducts and the challenge of controlling a chain reaction in the reactor.

Nuclear fusion


+ Energy

In contrast, fusion is the process by which two light atomic nuclei combine to form a single, heavier nucleus, releasing a tremendous amount of energy. A portion of the mass of the original nuclei is converted into energy according to Einstein's equation $E=mc^2$.

1kg of fusion fuel could in theory replace…

55.000
barrels of oil

6,000,000kg
natural gas

10,000,000kg
coal

“ Fusion energy can position Europe as the global market leader for CO_2-free, clean and secure energy, reduce energy imports and, in the long term, ensure a secure energy supply.
In order for Europe to play a leading role in the development and commercialisation of fusion energy, it is necessary to prioritise this promising and strategic technology and provide the backing of politics, industry and society.

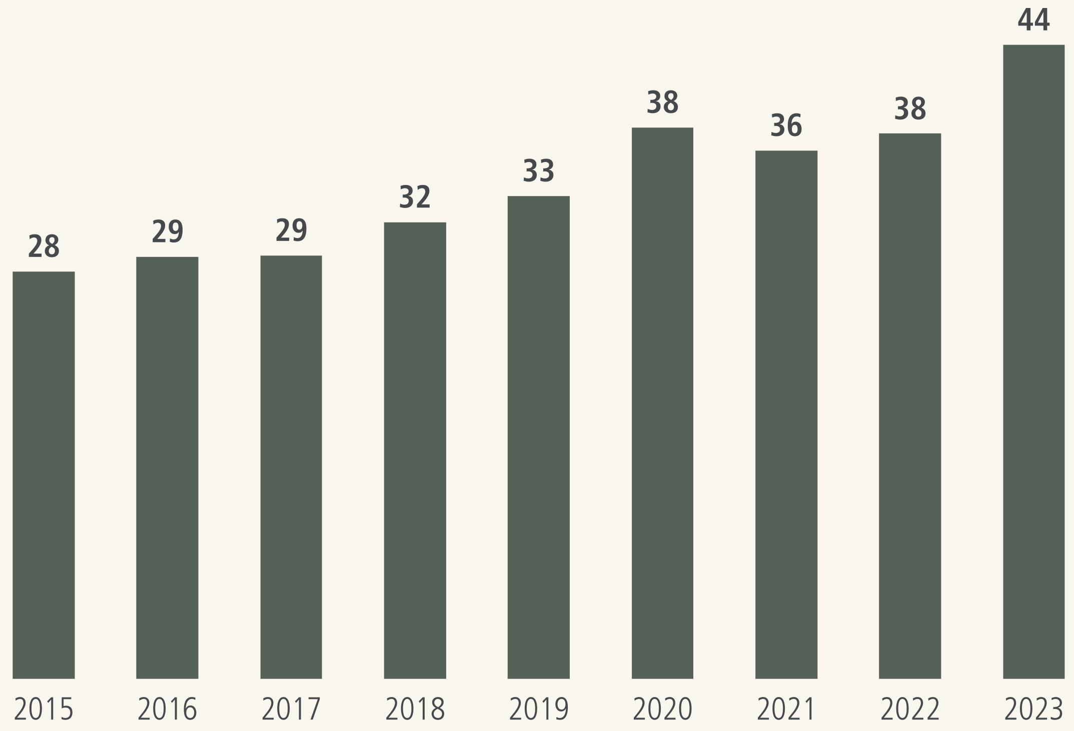
We are currently developing an innovative and tailored laser architecture that will enable a leap from current lasers to compact, efficient, reliable lasers with required physical properties.

MORITZ VON DER LINDEN

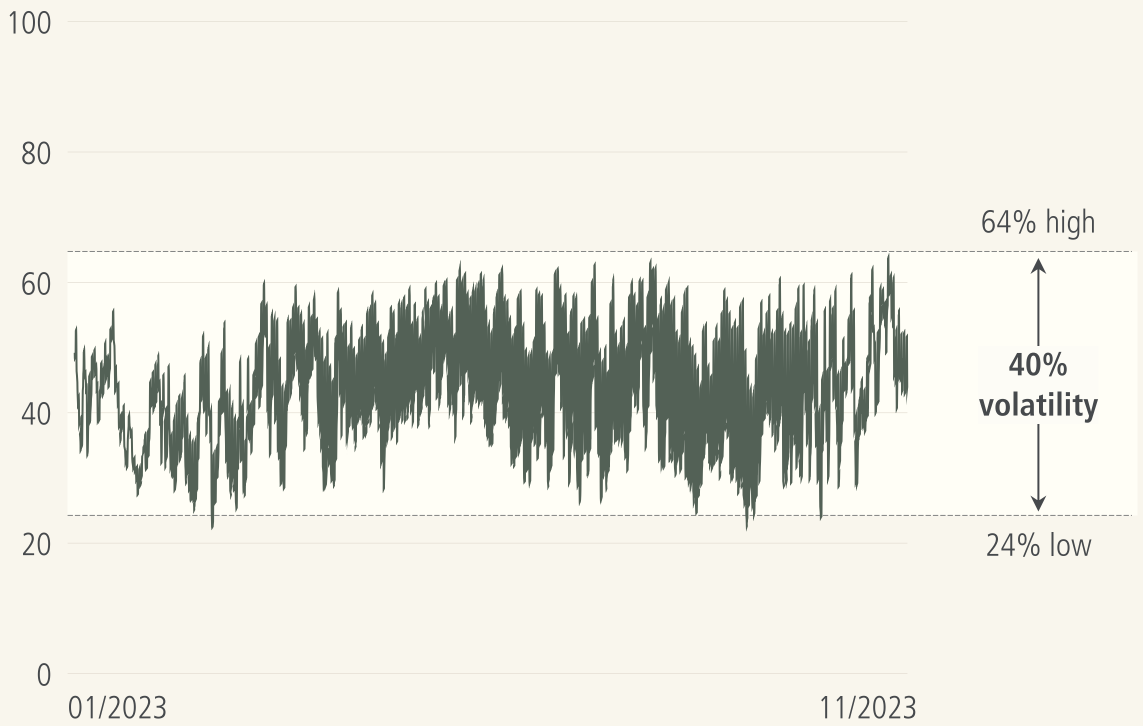
CEO OF MARVEL FUSION

As the share of renewables is increasing, the energy markets and grids have to deal with higher volatility which requires new forms of storage

Annual renewable share of public net electricity generation in the EU
%



Public net electricity generation in the European Union in 2023
% renewable share



LAKE STAR

(W)C Walden Catalyst

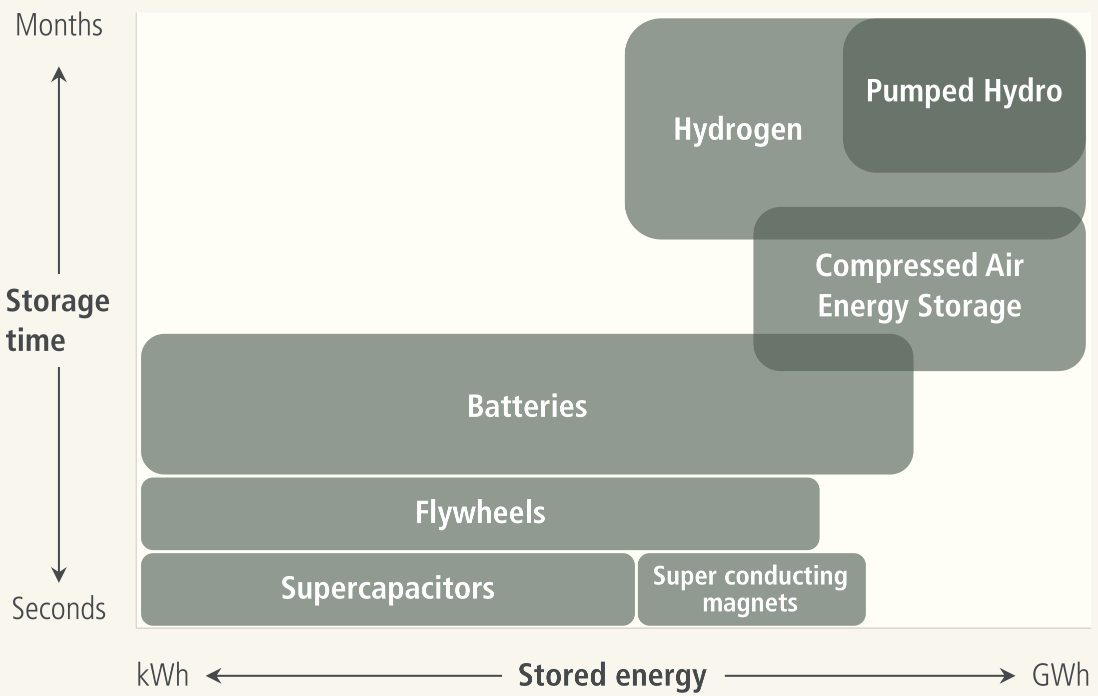
dealroom.co

Source: ENTSO-E, AGEE-Stat, Destatis, Fraunhofer ISE, AG Energiebilanzen

Hence, new forms of energy storages with varying characteristics are required

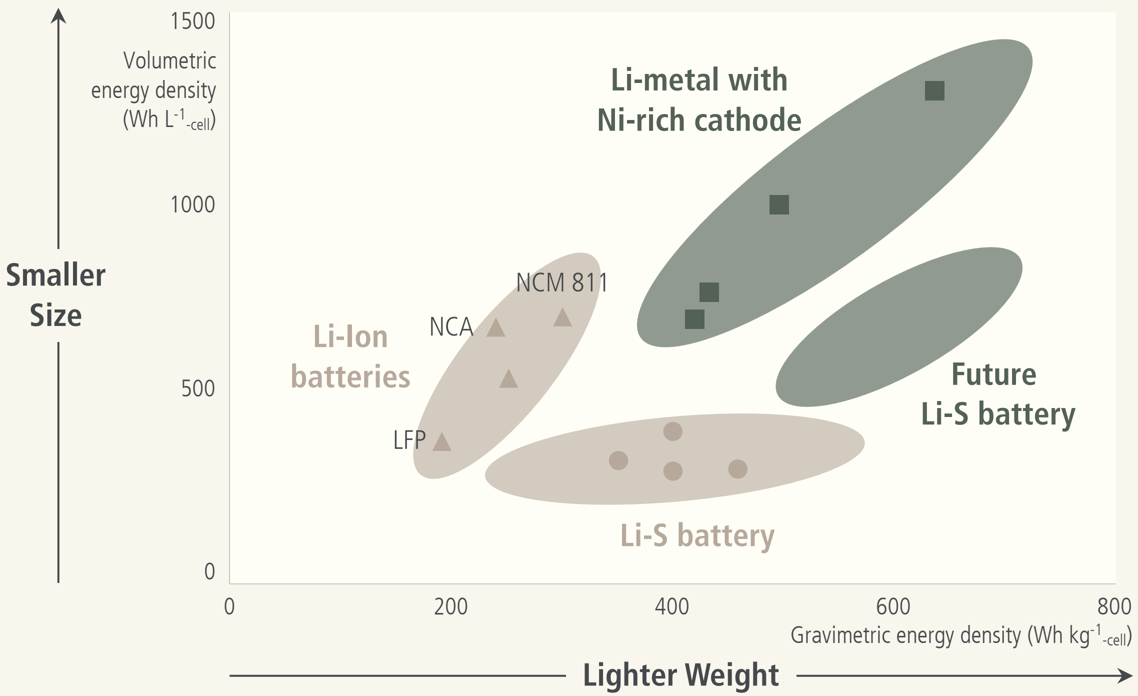
The new technologies need to address different energy needs: From storing kWh to GWh, and from short-duration to long-duration storage

High-level overview of storage technologies[1]



Within batteries, future breakthroughs in Li-metal and Li-sulfur or Li-Air chemistries could unlock new use cases from ultra-fast charging, to eAviation, and EV ranges of 1000km+

Battery cell chemistries by volumetric and gravimetric energy density[2]



LAKE STAR (W)C Walden Catalyst dealroom.co

1. Source: Stetson N. and Wieliczko M., 'Hydrogen technologies for energy storage: A perspective', Cambridge University Press, 9 Dec 2020.
2. Source: Liu Ya-Tao, Liu Sheng, Li Guo-Ran, Gao Xue-Ping, 'Strategy of Enhancing the Volumetric Energy Density for Lithium–Sulfur Batteries', Advanced Materials, 24 Feb 2021.

Breakthroughs in battery chemistries will unlock new use cases like eAviation

“Regarding power generation, the swift progress and acceptance of modular nuclear energy production, especially through advanced modular reactors (AMRs), will profoundly influence the energy sector.

On the storage front, the advancement of battery technologies, especially through the incorporation of silicon-based materials, is on the brink of creating new markets and establishing a high-end category capable of rapid charging and extended range. This represents a significant advancement in usability, unlocking new potential applications.

For instance, I anticipate a stronger-than-anticipated surge in the adoption of e-Aviation due to an underestimation of the technology’s scalability and business model potential.

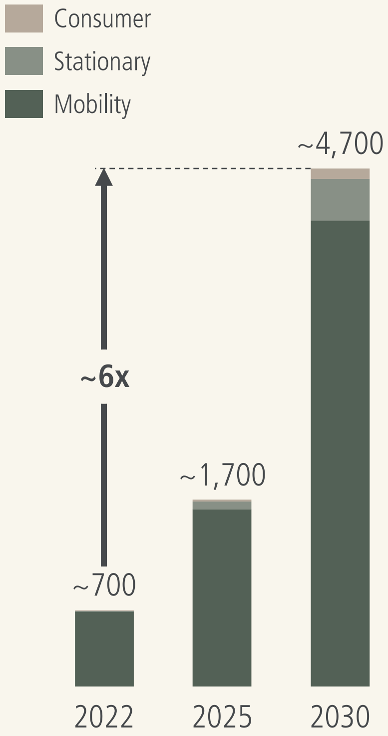
Nonetheless, obstacles persist, notably regarding battery lifespan, necessitating breakthroughs in general process technology like pre-lithiation. Safety concerns and comprehensive software integration throughout the entire lifespan remain a primary area of focus.

HERBERT MANGESIUS

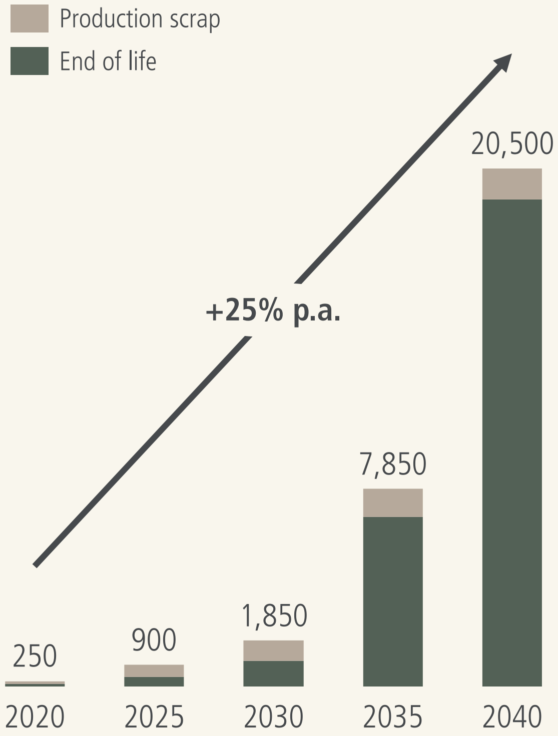
FOUNDING PARTNER AT VSQUARED

Global demand for batteries, regulatory pressure, and resource scarcity require new recycling technologies

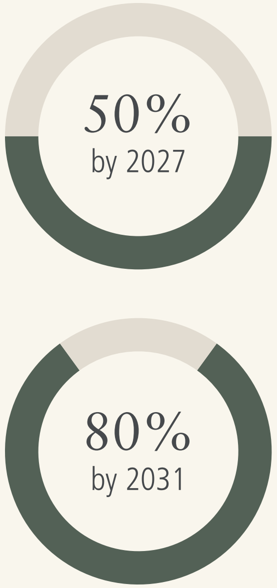
Global Li-Ion battery cell demand
GWh, Base case



Global supply of EV batteries for recycling
kt



EU regulatory targets for Lithium recovery from waste batteries



“We need battery recycling in Europe to mitigate import dependencies for the raw materials we need to build batteries.

Here, it is crucial to establish holistic and sustainable approaches to fully close the loop and to build out a pioneering role by technological excellence.

There are also innovative battery systems conquering the market – therefore, the recycling processes need to be flexible to meet the demands of the next generation's systems. From batteries to batteries, made in Europe.

LILIAN SCHWICH

FOUNDER OF CYLIB

LAKE STAR

(W)C Walden Catalyst

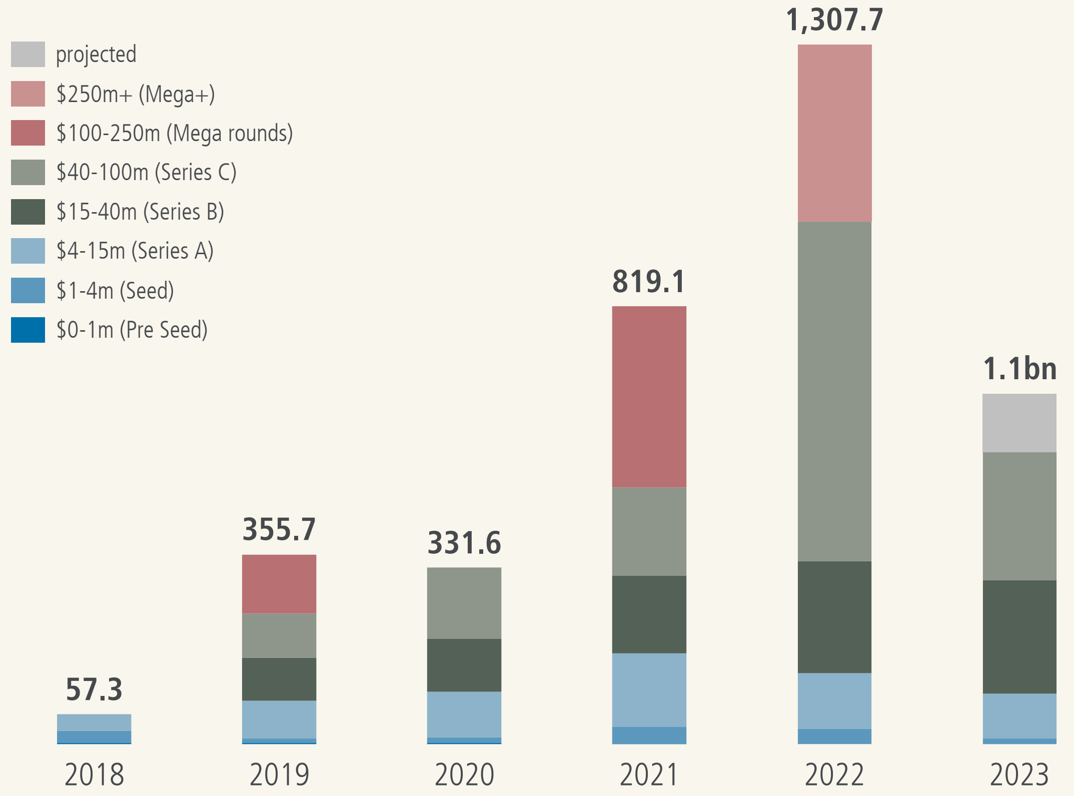
dealroom.co

Source: McKinsey Battery Insights Demand Model, McKinsey Battery Insights, 2022

The funding in Novel Energy has decreased by ~50% compared to 2022

VC investment in European Novel Energy startups

$ m



Notable European Novel Energy rounds in 2023

Startup	Funding round	Focus
Skeleton Technologies	€104m Late VC	Supercapacitors
Core Power	$80m Late VC	Advanced nuclear power for maritime transport
Energydome	€55m Series B	Long-term energy storage with liquid CO_2
Mecaware	$32m Series A	EV battery recycling
Norsepower	€28m Series C	Wind propulsion for ships
hystar	$26m Series B	PEM green hydrogen electrolysers

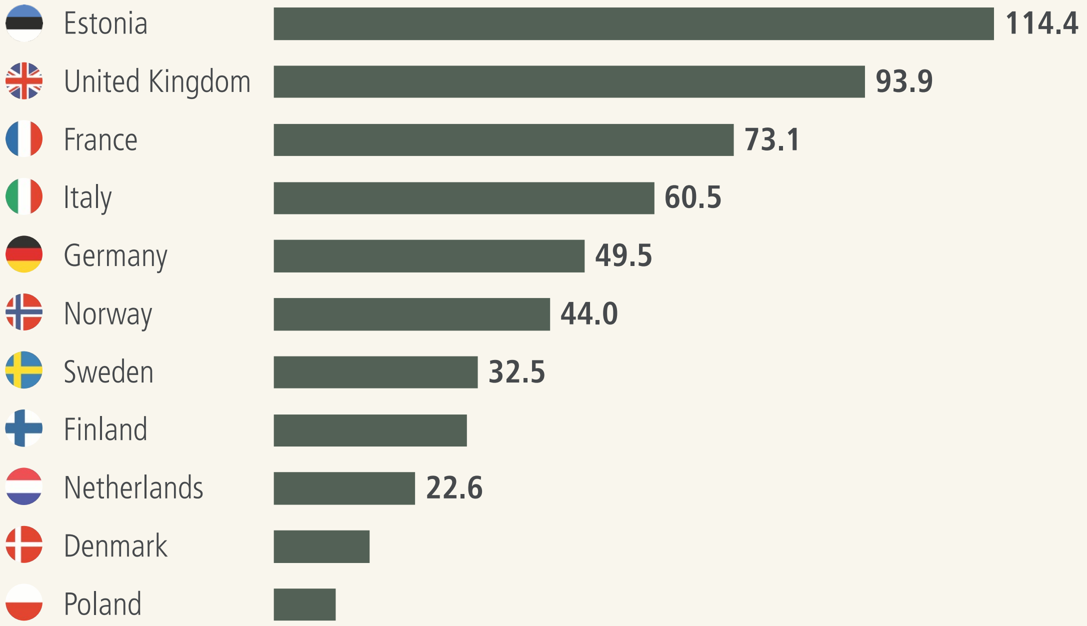
LAKE STAR

(W)C Walden Catalyst

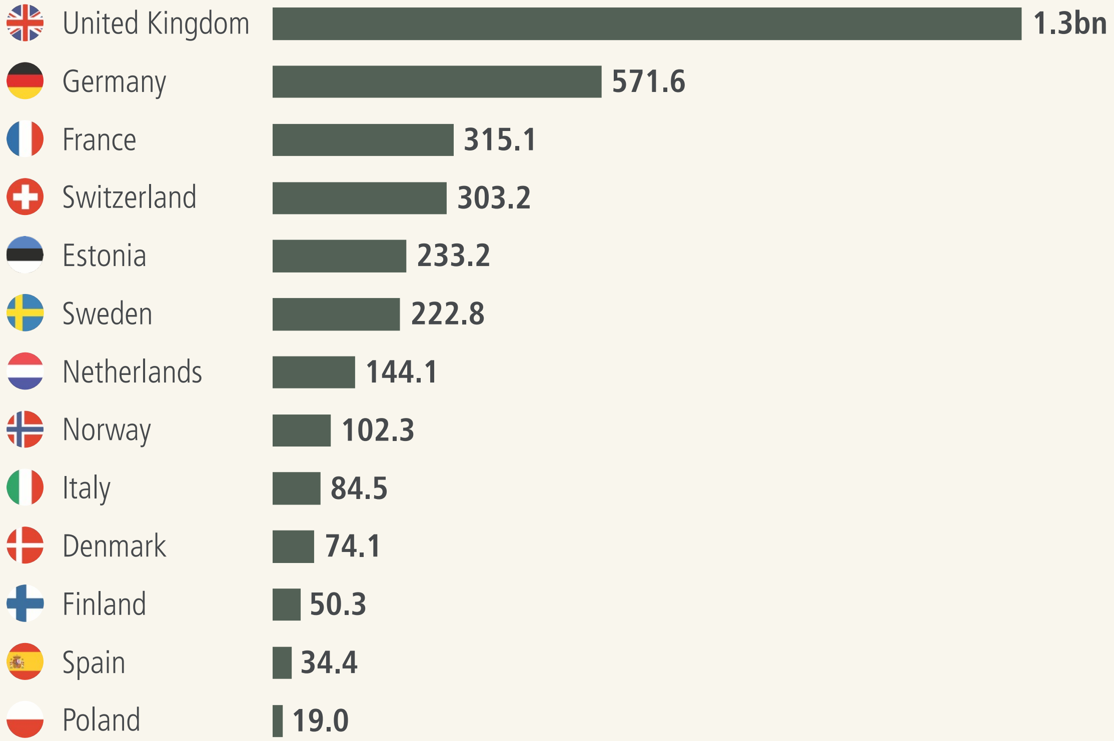
dealroom.co

UK has attracted the most Novel Energy funding since 2018, followed by Germany. Estonia is the top country in 2023 (driven mostly by Skeleton Technologies)

VC investment in Novel Energy startups by country, 2023
$ m



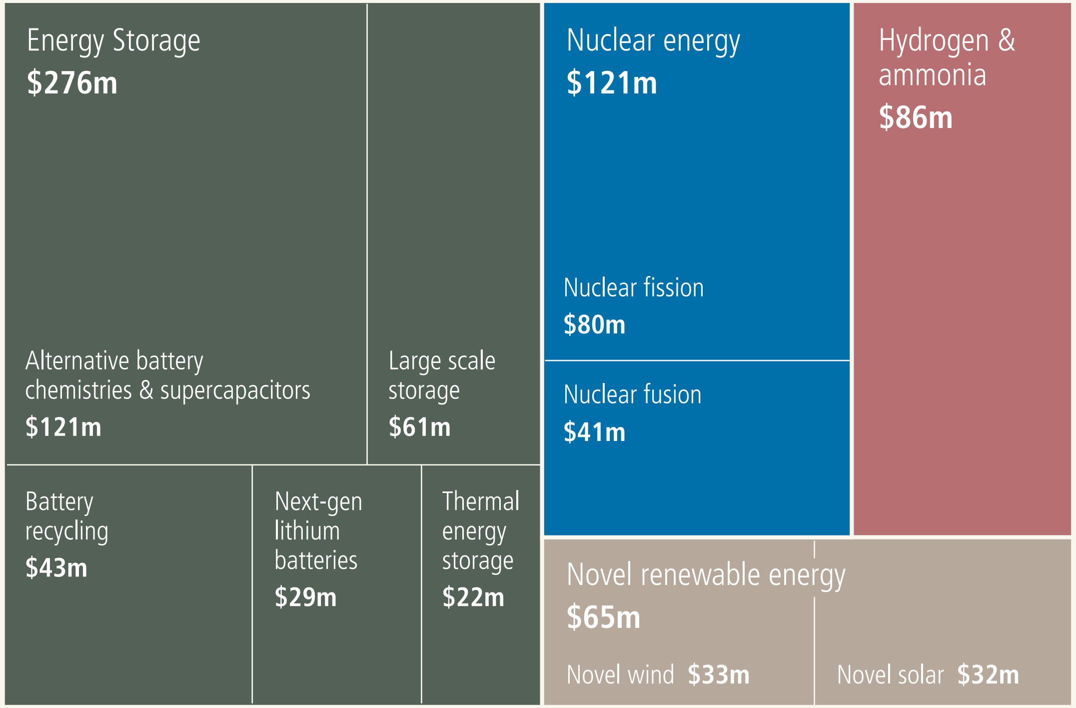
VC investment in Novel Energy startups by country, 2018-2023
$ m



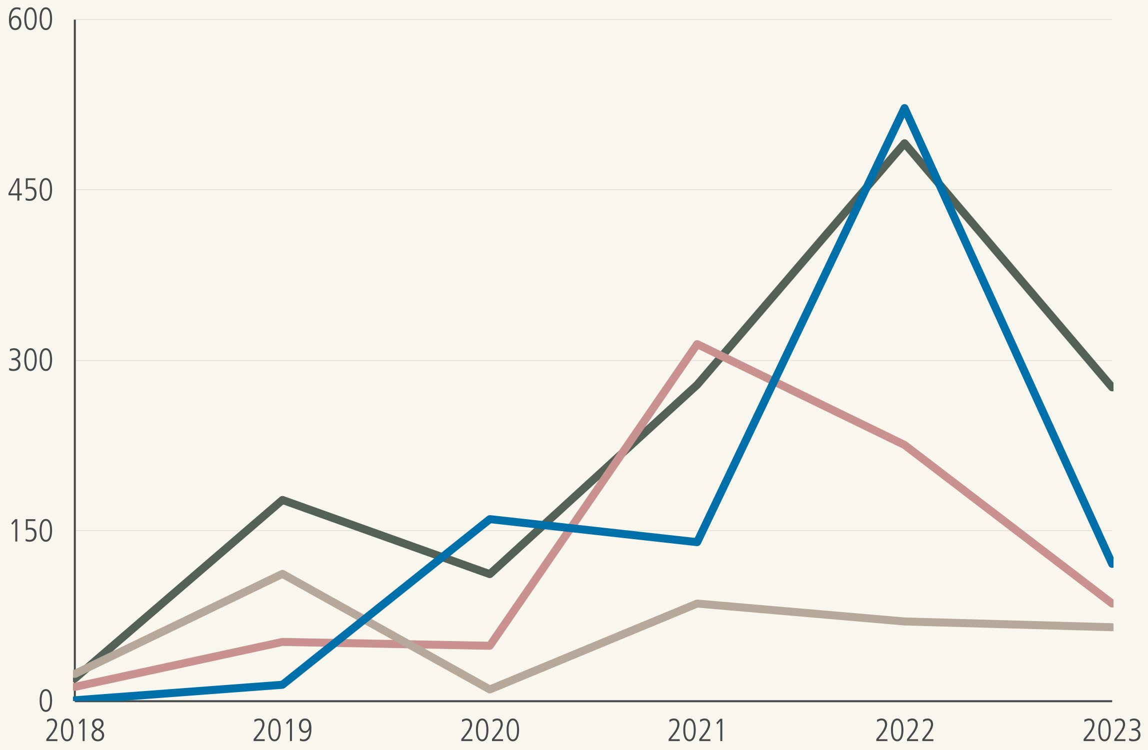
LAKE STAR
(W)C Walden Catalyst
dealroom.co

All segments have seen lower VC financing – batteries, hydrogen and nuclear fission remain the most funded categories

European Novel Energy funding by segment, 2023
$ m



European Novel Energy funding by segment, 2018-2023
$ m



LAKE STAR

(W)C Walden Catalyst

dealroom.co

Specialised and government funds enter at early-stage and international corporates at growth-stage

Most active early-stage investors in European Novel Energy startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Bpifrance	France	Seed	7	1
EIC Fund	EU	Early VC	6	2
AP Ventures	UK	Early VC	6	2
Kreaxi	France	Seed	5	2
Vopak	Netherlands	Early VC	5	2
Parkwalk Advisors	UK	Series A	5	0
Région Sud Investissement	France	Seed	4	1
Vsquared Ventures	Germany	Seed	4	1
Equinor Ventures	Norway	Series A	4	1
SOSV	USA	Seed	4	0
IP Group	UK	Seed	4	0
BOM Brabant Ventures	Netherlands	Early VC	4	0
CDP Venture Capital	Italy	Seed	3	2
360 Capital Partners	France	Seed	3	2
Positron ventures	Netherlands	Seed	3	1

Most active growth-stage investors in European Novel Energy startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Invest-NL	Netherlands	Late VC	6	1
SoftBank	Japan	Series C	4	0
Marubeni	Japan	Series B	3	2
Mitsubishi Corporation	Japan	Series C	2	1
Evonik Venture Capital	Germany	Series C	2	1
Climate Investment	UK	Series B	2	1
Saudi Aramco Energy Ventures	Saudi Arabia	Series B	2	0
TotalEnergies Ventures	France	Series B	2	0
Eurowatt	France	Series B	2	0
Hyundai Motor Company	South Korea	Series B	2	0
Eren Groupe	Luxembourg	Late VC	2	0
Harju Elekter Group	Estonia	Series D	2	0
Hostplus	Australia	Series B	2	0
Inven Capital	Czech Republic	Series B	2	0
Goldwind	China	Series D	2	0

LAKE STAR (W)C Walden Catalyst dealroom.co

COMPUTATIONAL BIOLOGY & CHEMISTRY

DEEP DIVE

EXAMPLES

PROTEIN DESIGN

DRUG DISCOVERY

SCREENING & TESTING

CELL & TISSUE MODELING

BIOMEDICAL IMAGE ANALYSIS

MICROBIOME

COMPUTATIONAL GENOMICS

MATERIAL MODELING

Encouraging developments in Computational Biology & Chemistry

Existing challenges

The progression of humanity faces crucial challenges and opportunities linked to the development of improved molecules and materials, particularly in pharmaceuticals, battery technology, solar energy, display systems, and climate sustainability. Historically, advancements in this area were largely a result of trial-and-error experiments, which were slow and expensive.

Leveraging AI to help solve some of these challenges is not a new idea and despite progress in simulation algorithms over the last few decades, the high compute costs limited the practical applications of these simulations, which were mostly confined to niche areas.

The potential for quantum computing to revolutionise computational molecule design is promising. However, the realisation of sufficiently powerful quantum computers appears to be some years away, leaving computational design of molecules seemingly insurmountable.

Current developments

Encouragingly, recent advancements present a shift in this landscape. The convergence of multiple factors is making these previously challenging areas more approachable.

Firstly, there has been an exponential progression in AI technology, leveraging new generative AI models like LLM and diffusion, bolstered by open-source tool chains, cloud infrastructure improvements, GPU advancements, and accessible vast datasets across various domains. The adaptation of generative AI models developed for language processing and image generation to solve complex issues in drug and battery design has shown promise.

Secondly, there's a more effective application of AI and compute in diverse fields such as battery technology and biotech. Researchers and startups are reshaping the problem by using their deep domain expertise to minimise material science or biology risks. They transform the challenges for AI and compute into search and optimisation tasks, leveraging AI's strength. This involves sifting through a large number of virtual experiments using AI/compute, followed by a smaller set of physical lab experiments to improve speed, accuracy, and cost.

Example use cases – Opportunities in drug discovery

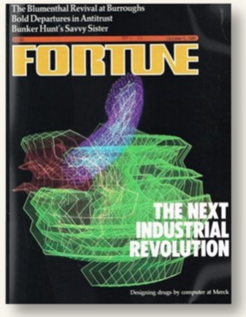
Taking drug design as an example, the separation of biology risks from physics/chemistry risks has led to the emergence of new drug modalities such as mRNA and "smart" targeted therapies. By combining a stable biology platform with a programmable and "digital" component, these therapies can be precisely customised, reducing the biological risks. This shifts the focus to manipulating the programmable digital part, aiming to leverage AI and compute to simulate numerous virtual molecules, subsequently conducting lab experiments on a select few physical molecules, thereby achieving efficiency, accuracy, and cost-effectiveness.

This transformation turns the challenge of drug design into a physics and chemistry simulation challenge, presenting an opportunity to apply AI and compute for the creation of improved molecules and materials. However, in order to be successful in drug development, you still have to prove that the derived hits have higher success rate in clinical trials.

Leveraging AI in biology & chemistry is not a new idea – however, despite three waves of innovation, there is still not a single AI-derived drug on the market

There have been several waves of excitement around AI and computational methods in Biology and Chemistry.

The first one as early as the 1980s, the second one right before the biotech bubble burst in the late 1990s, and the most recent one with the onset of LLMs and other Generative models.



Despite the clear value proposition of computational methods in theory, the high dimensionality, conditionality and complexity of biology has prevented a single AI-enabled drug from making it successfully through clinical trials.

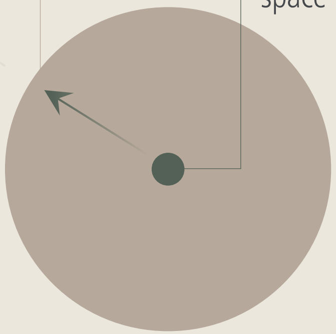
However, we believe it's only matter of time and data – at a fundamental level, all biology is computational biology.

Chemical Space

10^{200} Potentially active molecules

10^{80} Atoms in the known universe

10^{9} Currently explored chemical space



Clinical success rate is the most important driver of R&D cost for pharma and has the highest willingness to pay

In drug development, de-risking drives value creation. Companies "de-risk" through scientific experiments or clinical studies. Yet, due to the exceptionally low probability of drug candidates successfully navigating all stages of development for FDA approval, drug programmes gain the majority of their value during Phase II and III of clinical trials.

At this stage, the program has significantly minimised risk, increasing the likelihood of completion (approximately 64% post-Phase II), thereby enhancing the Net Present Value (NPV) of the programme. **Until AI drug discovery platforms can improve clinical success rates, the willingness of pharma companies to invest will remain constrained.**

Drug discovery and development process	DISCOVERY				DEVELOPMENT				
	Target-to-hit	Hit-to-lead	Lead Optimisation	Pre-clinical	Phase I	Phase II	Phase III	Submission to launch	Launch
Success rate									
P(success per stage)	80%	75%	85%	69%	54%	**34%**	**70%**	91%	
P(asset reaching given stage)	80%	60%	51%	35%	19%	**6%**	**5%**	4%	
P(final FDA approval once a given stage is reached)	4%	5%	7%	8%	12%	**22%**	**64%**	91%	

Value creation & highest willingness to pay

Source: Paul et al Nature Reviews Drug Discovery 2010

AI has already delivered a lot of value in the discovery phase of drug development but has failed so far to create drugs with higher clinical success rates

	DISCOVERY				DEVELOPMENT
Examples of AI & computational methods	**Target-to-hit**	**Hit-to-lead**	**Lead Optimisation**	**Pre-clinical**	**Clinical**
	Exploration of new chemical space to identify new targets	Protein backbone predictions	Structure and property prediction using Generative AI	Enhanced toxicity modelling & prioritisation of candidates	**Patient selection:** AI-enabled patient population selection for clinical trials using privacy enhancing technologies **Holy grail:** AI-enabled drugs with higher clinical success rate
Timeline					
Without AI	5-7 years				5-7 years
With AI	3-5 years				5-7 years

“Computational methods including those using recent AI tools will be used increasingly in drug R&D.

However, it remains to be seen if the impact will be just incremental on what went before or a more profound breakthrough. Currently only a few drugs designed using AI have gone into human testing and it’s really too early to say. More real-world validation of AI-designed drug candidates is needed to demonstrate the true utility of AI in drug R&D.

ALEX PASTEUR

PARTNER AT F-PRIME

LAKE STAR

(W)C Walden Catalyst

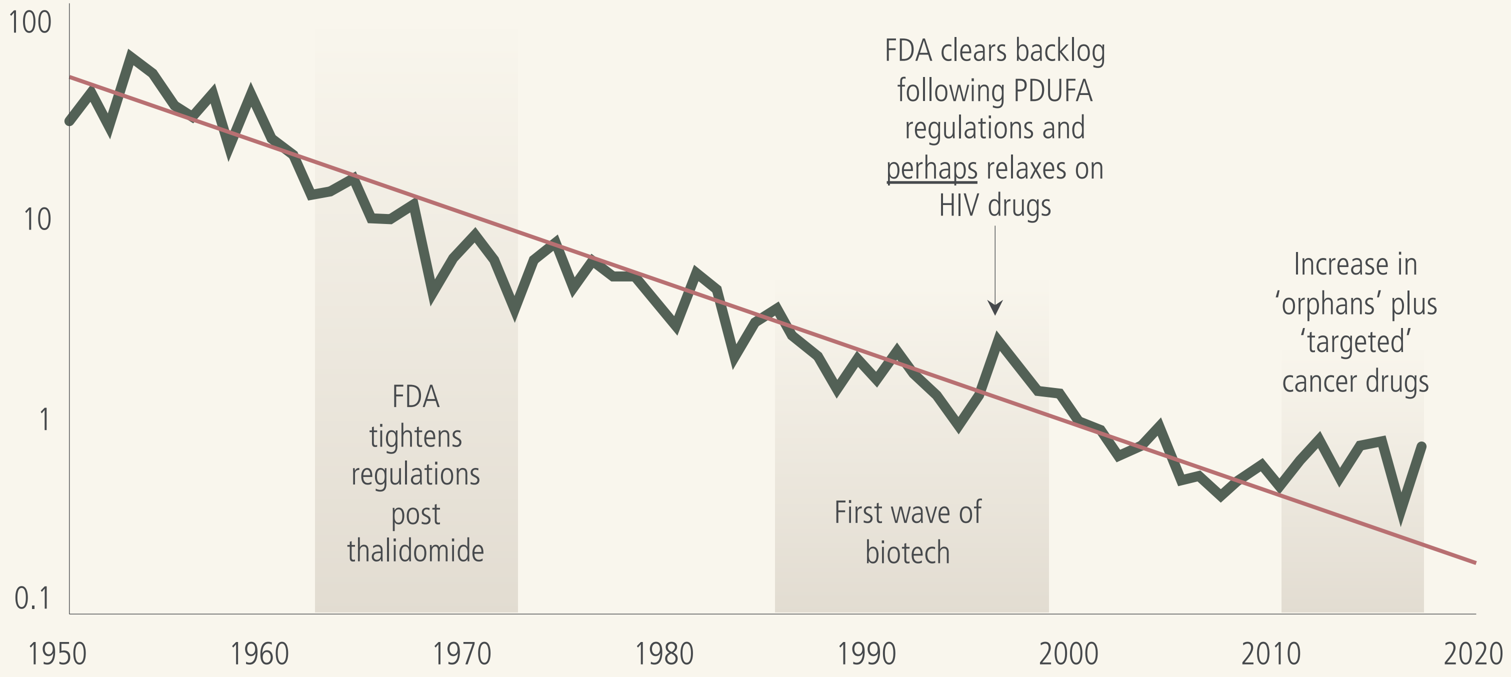
dealroom.co

In drug development, Pharma companies are looking for new technologies to fight the decreasing efficiency

8.4% p.a. decrease in new drugs per $ billion R&D

Eroom's law

New drugs per $ bn R&D (log scale)



LAKE STAR

(W)C Walden Catalyst

dealroom.co

Source: Nature Reviews Drug Discovery, Feb 2023

> "Drug discovery is a field that has reached a high level of maturity, facing increasingly complex challenges. As the easier therapeutic targets and biological mechanisms become well-understood, research is increasingly directed at more complex diseases, biology and chemistry, resulting in a slower and costlier discovery process.
>
> Additionally, the field's advancement has brought about tighter regulatory demands for safety and efficacy, further extending and escalating the expense of clinical trials.
>
> Computational biology and chemistry hold the promise of revolutionising drug discovery by enabling the rapid invention of new therapeutic molecules.

MAXIMILIEN LEVESQUE & EMMANUELLE MARTIANO ROLLAND

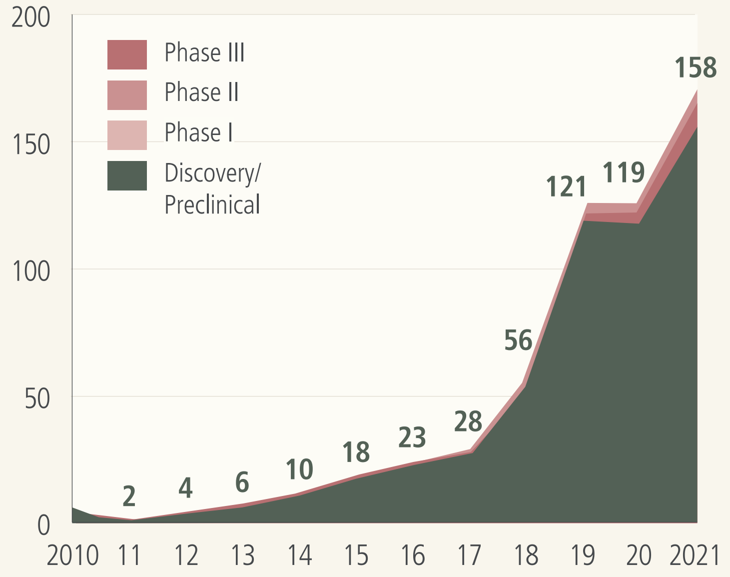
FOUNDERS OF AQEMIA

There is a growing pipeline of AI-enabled drugs in the early development stages

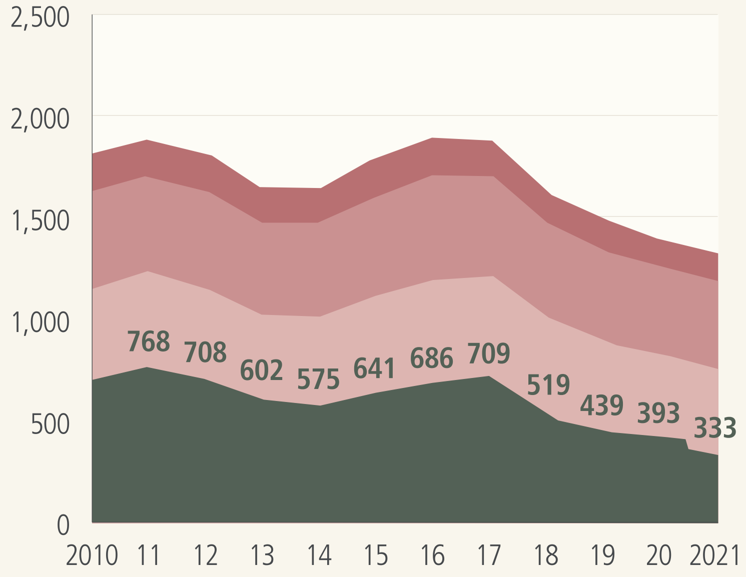
Small molecule assets in the top 20 pharma companies have declined over time, indicating a decrease in the efficiency of R&D. In contrast, AI-native companies have established a pipeline of AI-enabled assets. However, most are still in the early and pre-clinical stages of development.

Number of clinical and pre-clinical molecule drug assets in the pipeline, 2010-2021

20 AI-native companies



Top 20 pharma companies



Source: Jayatungaet al., ‘AI in small-molecule drug discovery: a coming wave?’ Nature Reviews Drug Discovery, 7 Feb 2022

LAKE STAR
(W)C Walden Catalyst
dealroom.co

“As biology becomes more and more digitised, computational methods and technologies are fast becoming an essential part of the drug discovery process. Companies like Recursion in the US and Exscientia in the UK are already heading a new generation of pharma built at the intersection of chemistry, biology and computation.

There is no limit to the scope of innovation that is unlocked by truly computational biology and chemistry: fully automated experiments designed by a scientist using just software; AI-driven drug repurposing, and foundation models to explore specific areas of biology like the cell.

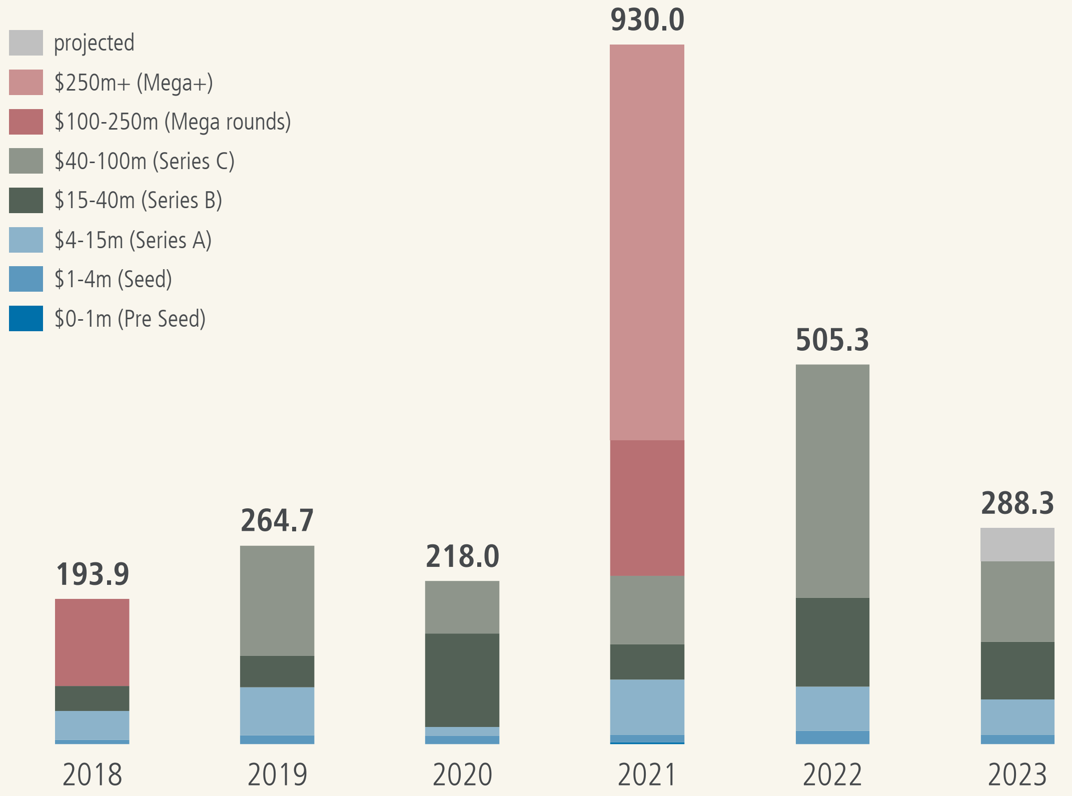
FERDINANDO SIGONA

PARTNER AT LOCALGLOBE

There were fewer large, pre-IPO funding rounds in 2023

VC investment in European Computational Biology & Chemistry startups

$ m



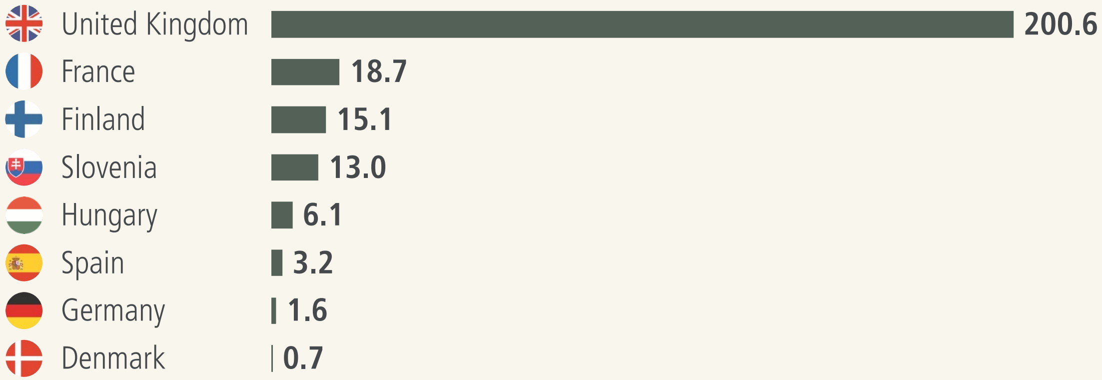
Notable Deep Tech rounds in Computational Biology & Chemistry in 2023

Startup	Funding round	Focus
causaly	$60m Series C	AI solutions for life sciences R&D
Chemify	£36.0m Series A	AI-drug and chemical discovery
evonetix	€22m Series B	DNA synthesis to accelerate research
CHARM THERAPEUTICS	$20m Series A2	AI-drug discovery
IKTOS	€16m Series B	AI-drug discovery
algorithmiq	€14m Series A	Quantum computing for drug discovery

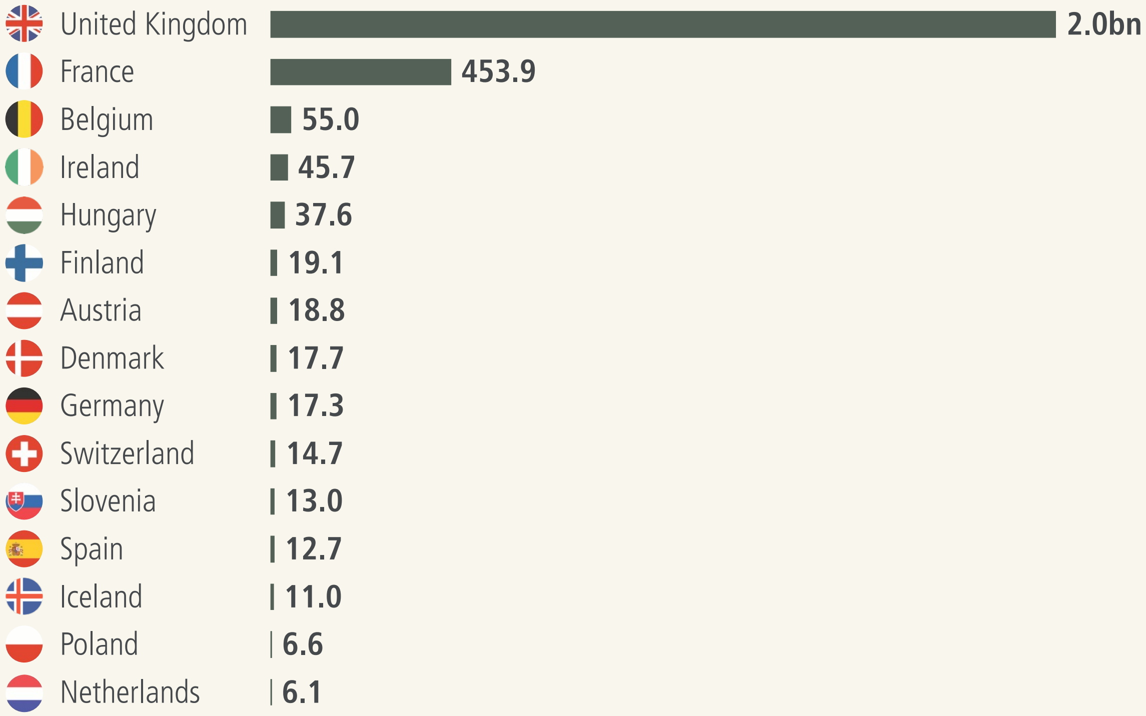
LAKE STAR
(W)C Walden Catalyst
dealroom.co

UK leads computational biology and chemistry funding

VC investment in European Computational Biology & Chemistry by country, 2023
$ m

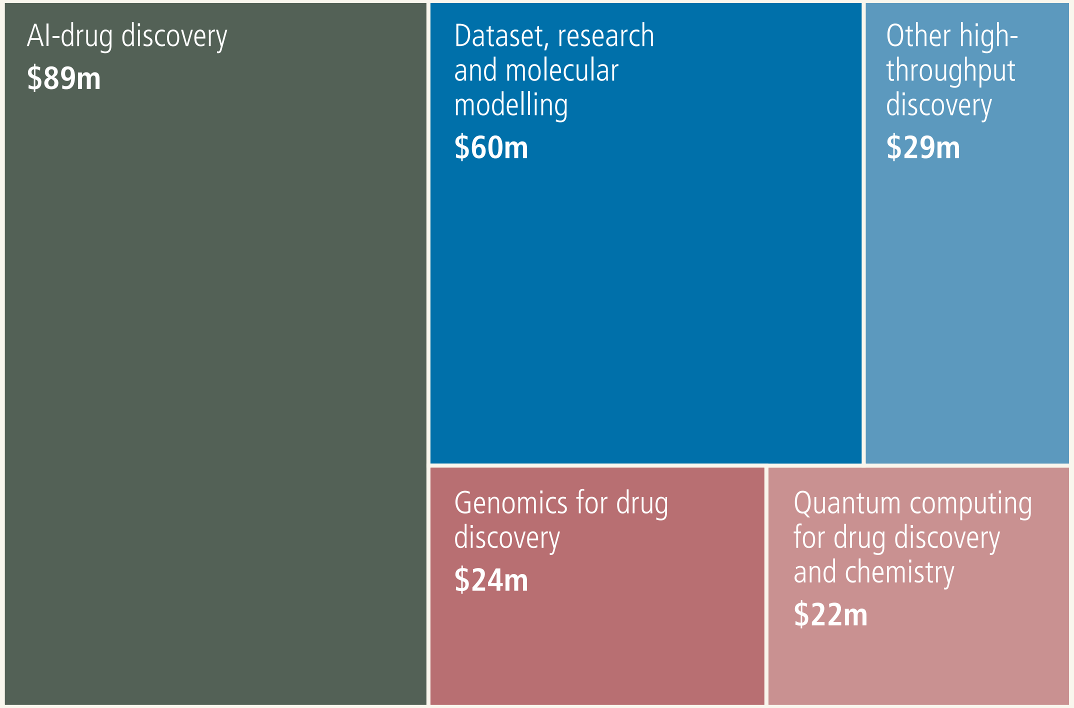


VC investment in European Computational Biology & Chemistry by country, 2018-2023
$ m

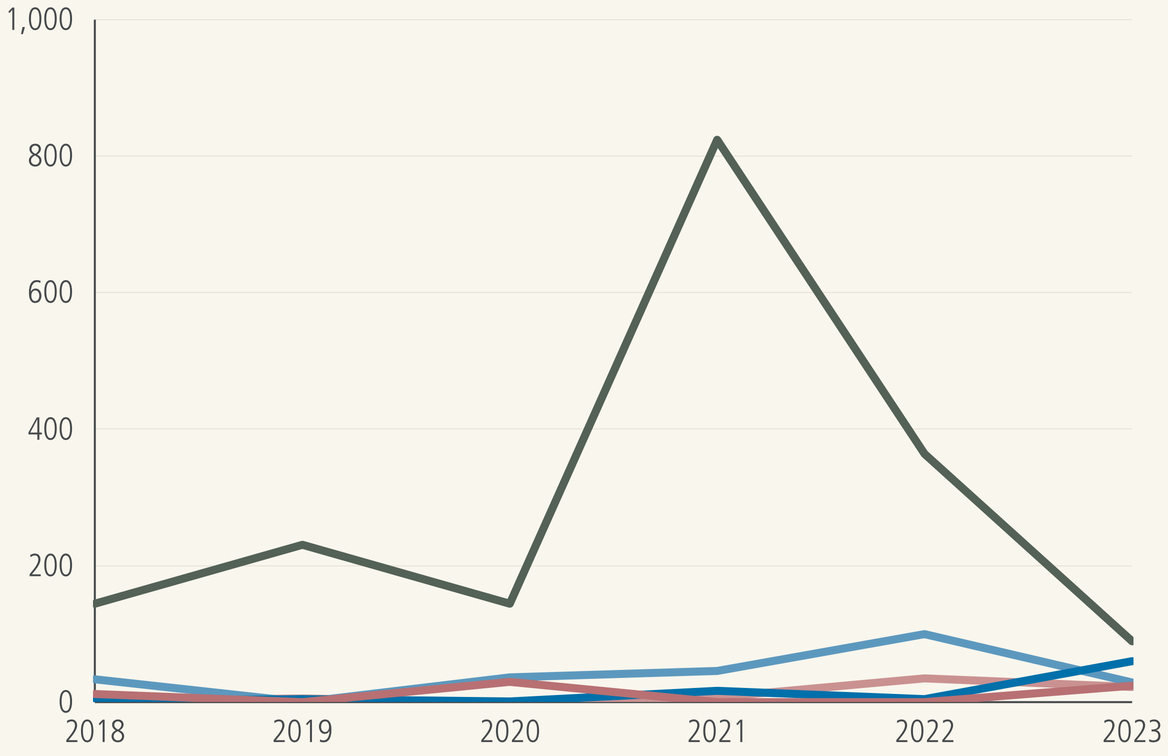


Although AI-drug discovery was the highest funded segment, its VC financing was comparably low in 2023

European Computational Biology & Chemistry funding by segment, 2023
$ m



European Computational Biology & Chemistry funding by segment, 2018-2023
$ m



LAKE STAR

(W)C Walden Catalyst

dealroom.co

UK and US investors dominate both early- and growth-stage

Most active early-stage investors in European Computational Biology & Chemistry startups

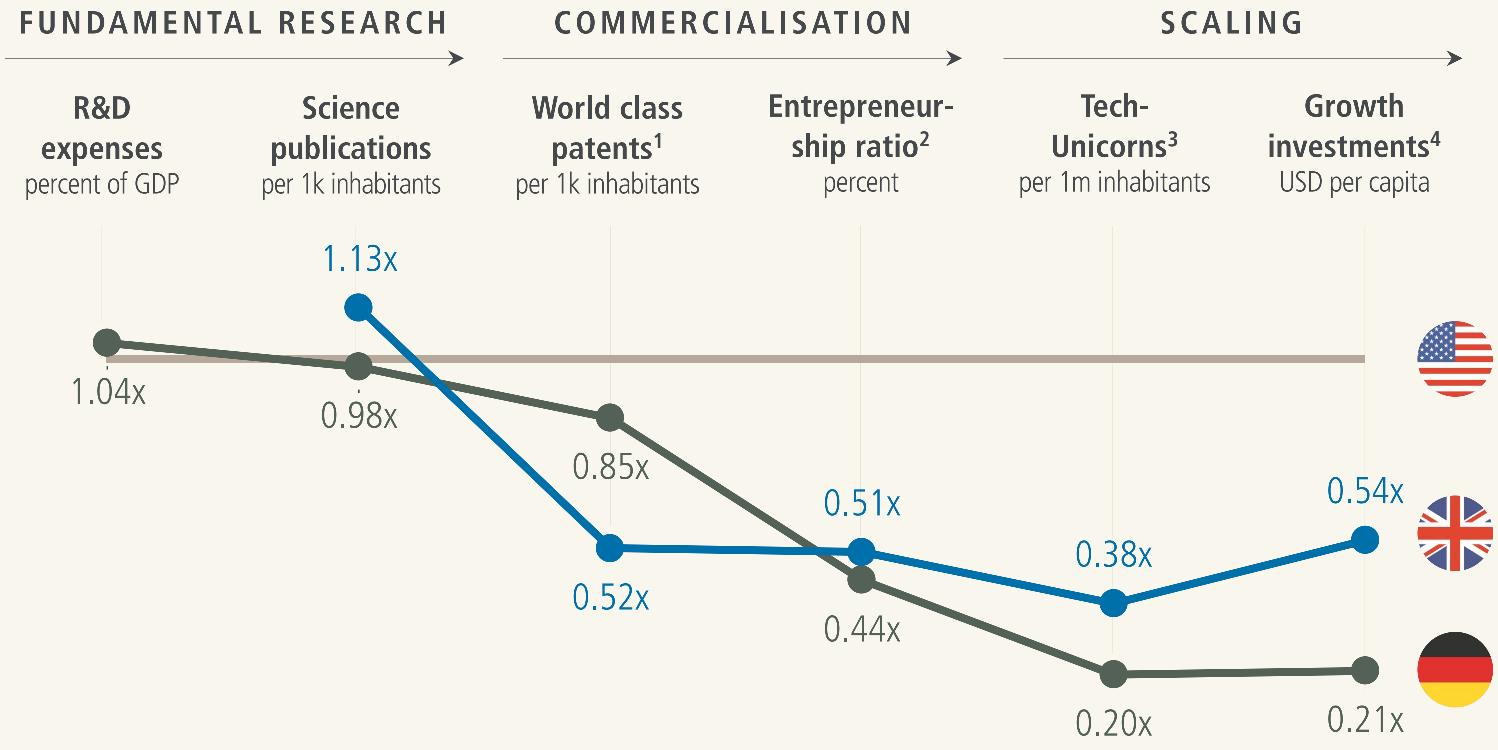
Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
O2h Ventures	UK	Seed	12	2
Pentech Ventures	UK	Series A	7	1
F-Prime	US	Series A	7	0
Oxford Science Enterprises	UK	Seed	7	0
EIC Fund (European Innovation Council Fund)	EU	Early VC	6	1
Hoxton Ventures	UK	Seed	5	1
ACF Investors	UK	Seed	5	1
SOSV	US	Seed	5	1
Khosla Ventures	US	Series A	5	0
Selvedge Venture	UK	Seed	5	0

Most active growth-stage investors in European Computational Biology & Chemistry startups

Investor	Country	Preferred round	Number of rounds 2018-2023	Number of rounds 2023
Foresite Capital	US	Series B	4	1
Cathay Innovation	US	Series B	4	0
Molten Ventures	UK	Series B	3	1
Woodford Investment Management	UK	Series B	3	0
Lansdowne Partners	UK	Series B	3	0
Bristol-Myers Squibb	US	Series B	3	0
Eurazeo	France	Series B	3	0
Novo Holdings	Denmark	Series C	3	0
Cambridge Consultants	UK	Series B	2	1
British Patient Capital (BPC)	UK	Series B	2	1

5.
CHALLENGES & RECOMMENDATIONS

Despite strong research, too few entrepreneurs and too little capital are available in Europe



1. Best 10% of all patents within one technology.
2. Share of inhabitants aged between 18 and 64 working in entrepreneurial position.
3. Startups with >1bn valuation with digital business model in B2B or B2C including internet, software and hardware.
4. Investments into private startups (excluding public companies).

LAKE STAR

(W)C Walden Catalyst

dealroom.co

Source: Bertelsmann Stiftung, natural Science Foundation, OECD, Dealroom.co, Worldbank

“Europe has great strength in our universities. Our research output is comparable to the US and a rising China. Our problem is one of translating this output into successful companies.

This is due to a lack of venture capital, which is still only one quarter of the US, and the low risk appetite of our great financial institutions including our stock exchanges.

The biggest *risk* for Europe is that we do not take enough *risks*!

HERMANN HAUSER

CO-FOUNDER OF ARM & DIRECTOR OF AMADEUS CAPITAL

Europe needs a more harmonised, standardised, and founder-friendly approach to spinout terms

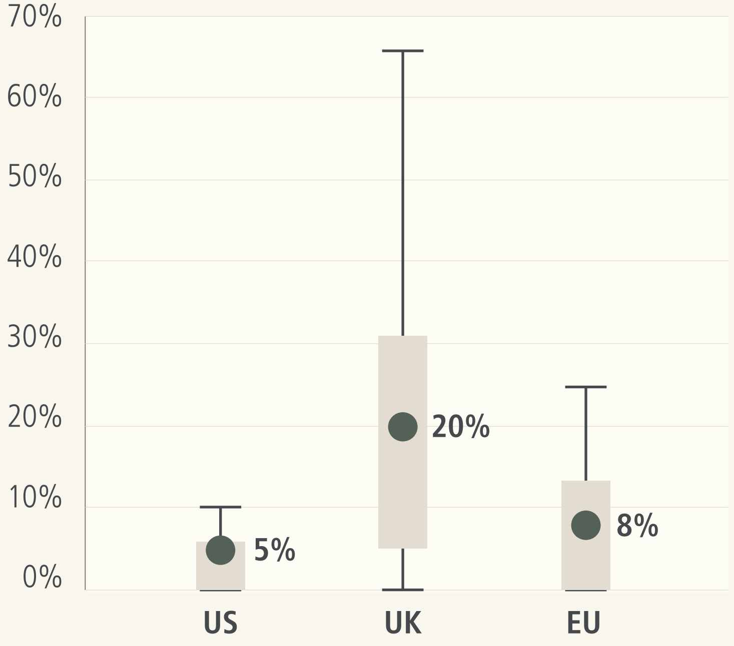
Similar trends on royalties and exit fees but much higher equity burden in Europe, especially in the UK

Summary of spinout terms by Geography

	UK	EU	USA	APAC
# of companies	94	66	28	9
Avg. royalties of net sales to the Uni/TTO	2.1%	1.6%	2.5%	0.8%
Avg. exit fee to the Uni/TTO	0.6%	0.7%	0.9%	2.2%
Avg. equity owned by Uni/TTO upon founding	**19.6%**	**8.0%**	**4.9%**	**6.4%**
% require board seat	41%	15%	7%	0%
Avg. months the deal took to complete	9	9	11	11

The UK and EU exhibit much greater variation regarding equity spinout terms

Distribution of % of equity owned by universities/TTOs by country



LAKE STAR
(W)C Walden Catalyst
dealroom.co

Source: https://www.spinout.fyi/data; Lakestar analysis

Europe needs to concentrate talent clusters to compound capabilities

Nothing unleashes the capability of smart people like the kinetic energy of being around other smart people working on similar challenges. This was as true for artists in renaissance Florence and philosophers in ancient Athens as it is for finance in London or tech in the Bay Area today. ***Europe's exceptional talent is too spread out***; founders, cities, and regulators need to pursue dense talent clusters to improve rates of success.

Global unicorns by city

38% of the global enterprise value of private unicorns is located in 3 US cities. Comparatively, only 5% is located in the top 3 European cities.

	Market cap ($bn)	% of market cap	Unicorn count	% of unicorns	Deca-corns	% of deca-corns
Bay Area	**1.1tn**	**25%**	**300**	**22%**	**21**	**36%**
Beijing	468.9	11%	91	7%	6	10%
New York	**287.4**	**7%**	**130**	**9%**	**2**	**3%**
Los Angeles	**257.4**	**6%**	**42**	**3%**	**2**	**3%**
London	**147.7**	**3%**	**45**	**3%**	**4**	**7%**
Boston	120.5	3%	44	3%	2	3%
Shanghai	120.1	3%	53	4%	2	3%
Bengaluru	110.6	3%	32	2%	2	3%
Paris	**59.8**	**1%**	**24**	**2%**	**0**	**0%**
Berlin	**46.8**	**1%**	**21**	**2%**	**0**	**0%**

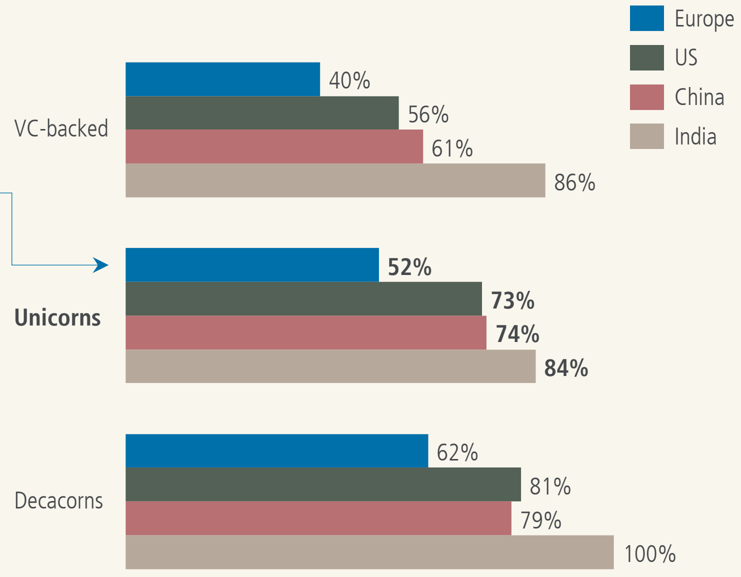
European unicorns by city

The top 3 cities in Europe have a total private unicorn enterprise value share of 52% in Europe. This indicates that hubs are forming.

	Market cap ($bn)	% of market cap	Unicorn count	% of unicorns	Deca-corns	% of deca-corns
London	**147.7**	**30%**	**45**	**24%**	**4**	**57%**
Paris	**59.8**	**12%**	**24**	**13%**	**0**	**0%**
Berlin	**46.8**	**10%**	**21**	**11%**	**0**	**0%**
Amsterdam	27.2	6%	9	5%	0	0%
Stockholm	25.3	5%	8	4%	1	14%
Munich	32.1	7%	8	4%	1	14%
Zurich	18.2	4%	5	3%	0	0%
Dublin	7.9	2%	5	3%	0	0%
Oslo	4.6	1%	4	2%	0	0%
Helsinki	9.5	2%	3	2%	0	0%

% of companies in top 3 hubs – by market cap

However, Europe hub concentration is low compared to 73% for the US, 74% for China, and 84% for India.



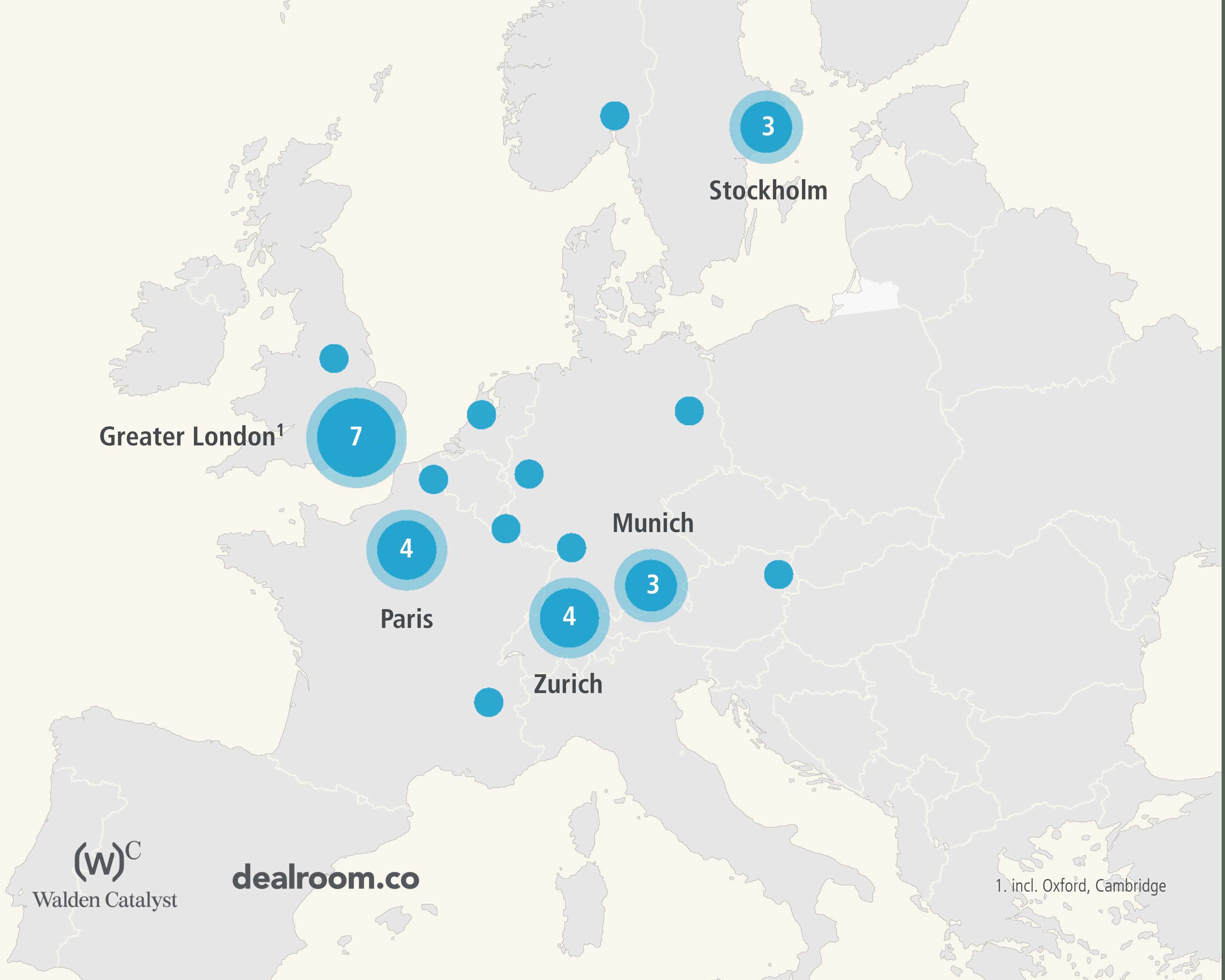
LAKE STAR

(W)C Walden Catalyst

dealroom.co

Unicorns here is used to refer only to privately, not acquired startups with $1bn+ disclosed valuation

Europe's 31 Deep Tech unicorns set the baseline for key Deep Tech hubs



1. incl. Oxford, Cambridge

"Growing up and working in Silicon Valley, the power of having lots of people, together, working on similar problems, was easily visible. The serendipitous breakthroughs that are made through casual conversations at a coffee shop or social gathering can often completely rewire how one thinks about a problem.

Universities and companies are great examples of this, but it's also true for cities. When more people pack together to work on a problem, the kinetic energy increases and the interactions between each individual and the others around them increases. This sparks not only the sharing of knowledge and best practices, but also the crossing over of seemingly unrelated approaches to problem solving.

Now is the time for Europe to cultivate its own technology epicentres, where pioneers converge, collide, and catalyse the future of technology borne from Europe.

STEVEN JACOBS

PARTNER & CPO AT LAKESTAR

Deep Tech companies in these hotspots are more globally competitive

London and Paris rank highest amongst all Deep Tech subcategories. If you're starting a Deep Tech company, those are good places to go to be amongst like-minded peers and benefit from ecosystem effects.

Future of Compute also tends to cluster in Eindhoven and Grenoble. *Quantum* specifically, has grown density in Helsinki.

If you're starting a *Space Tech* company, Munich and Toulouse are great places to set up shop.

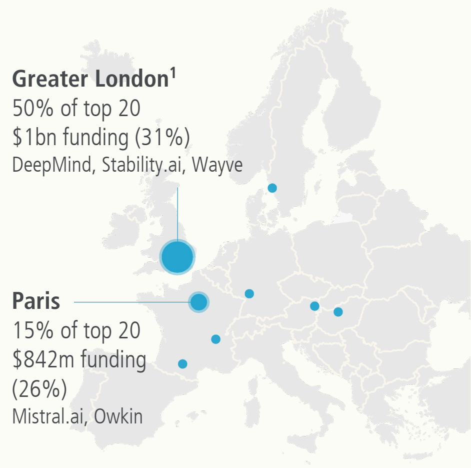
For *Novel Energy* companies, the ecosystem is very distributed, apart from London.

LAKE STAR

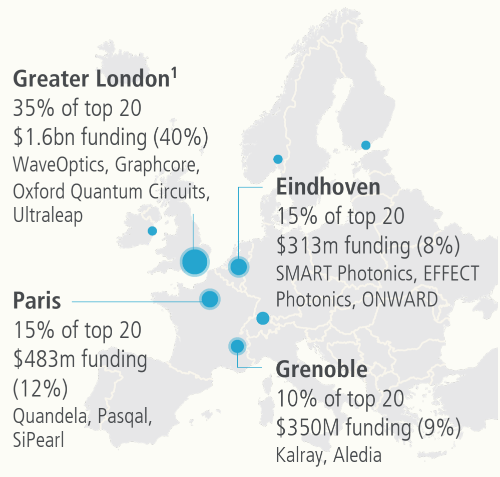
(W)C Walden Catalyst

dealroom.co

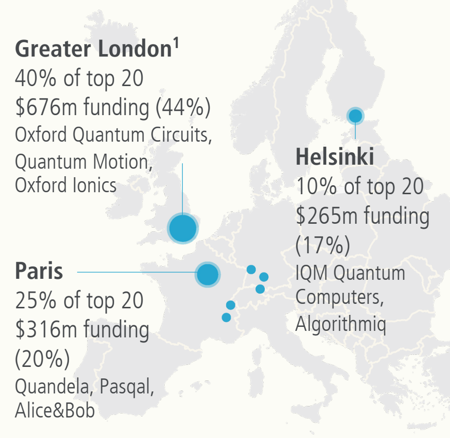
NOVEL AI



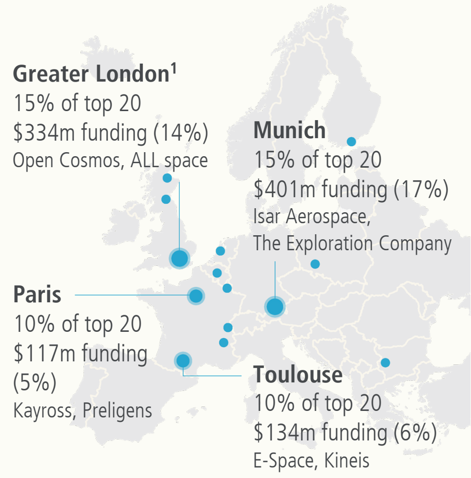
FUTURE OF COMPUTE



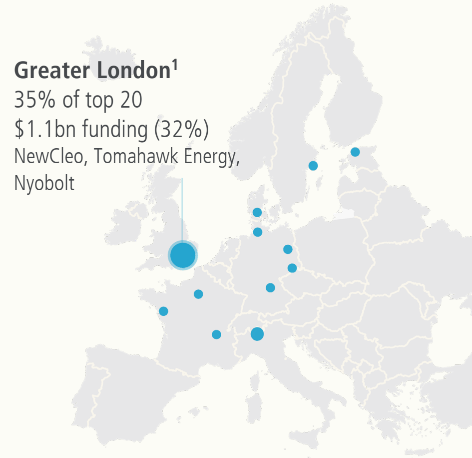
QUANTUM



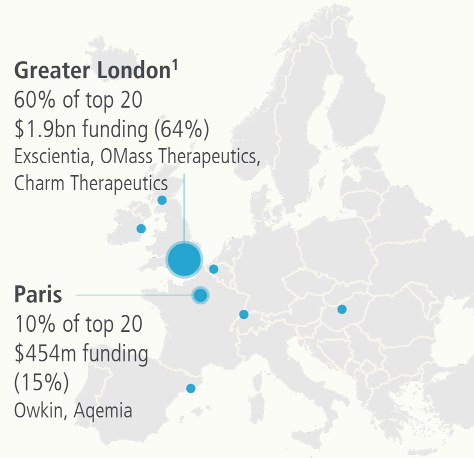
SPACE TECH



NOVEL ENERGY



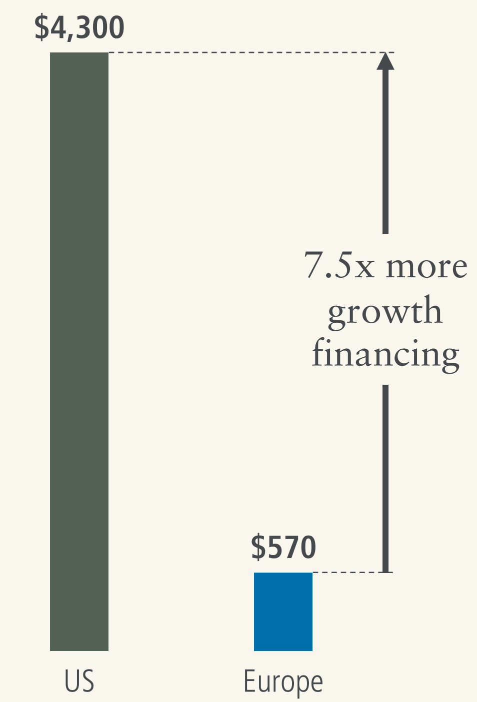
COMPUTATIONAL BIOLOGY & CHEMISTRY



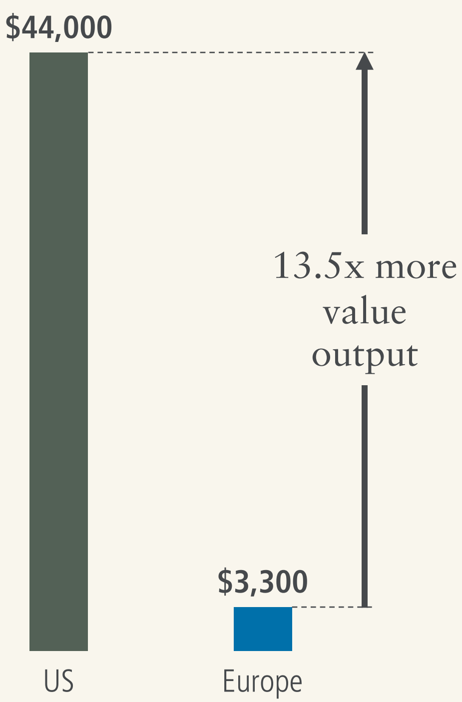
1. incl. Oxford, Cambridge

We need more growth financing and value creation in Europe

Cumulated growth financing per capita, 2000-2023



New value creation per capita[2] from growth companies, 2000-2023



LAKE STAR

(W)C Walden Catalyst

dealroom.co

For public companies based on latest known valuation per IPO date (value increase after IPO not included.)
Source: Dealroom.co

“In the last decade, European-based Deep Tech companies were struggling to find growth funding. Macroeconomic and geopolitical developments have raised public awareness that deep technologies are a crucial factor in addressing topics such as technology sovereignty and climate. Consequently, the capital gap is closing with government programmes being active on a national and European level.

Most importantly, we will need skilled growth investors that can lead and price funding rounds. They must have strong capabilities in assessing transformational technologies and, at the same time, support companies in building robust, sustainable, and profitable businesses. Then we will generate massive returns from European Deep Tech growth investments in the next 10 years.”

SUSANNE SCHORSCH

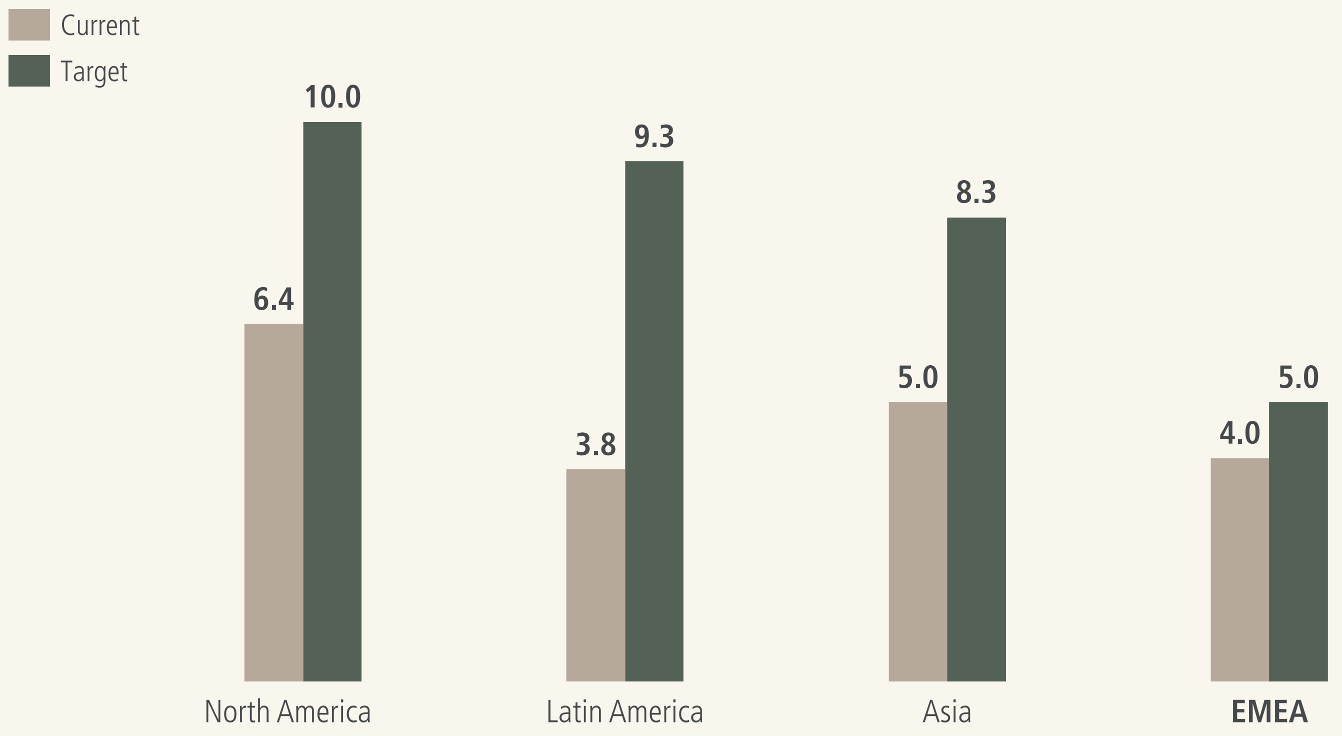
PARTNER AT AMADEUS CAPITAL PARTNERS

Across the globe, institutional investors are increasing target allocations into private equity, but Europe is lagging behind

Compared to asset allocation of institutional investors across the globe, European institutional investors' allocation to private equity is relatively small with 3.6% in Western Europe and 4.4% in the UK (4.0% average) and target allocations only reaching ~5.0% in 2019.

In the US, median allocation to private equity is higher with 6.4%. Similarly, the Asia average is 5% with target allocations reaching 8.3% (China at 10% and targeting over 17%).

Share of private equity in asset allocation of institutional investors, 2019
%



Source: Preqin Pro

European governments & institutions need to embrace their roles as customers of Deep Tech companies – not as project managers

SpaceX's success relied significantly on the role played by the US government and its affiliated institutions as essential customers. This reciprocal partnership has been pivotal in propelling the resurgence of the space economy, predominantly driven by the innovation fostered within private enterprises. This trend extends beyond space to various other sectors, including Energy and Healthcare.

Conversely, European governments and agencies have yet to embrace acting as customers, rather than assuming the role of project managers. Although Europe offers substantial contracts, these opportunities often come burdened with intricate bureaucratic procedures, inadvertently impeding the pace of innovation and escalating its complexity.

SPACEX

Milestones

- **2002** Elon Musk founds SpaceX
- **2008** 1st rocket to reach orbit
- **2012** 1st spacecraft sent to ISS
- **2015** 1st landing on land
- **2017** 1st orbital rocket reused
- **2020** 1st company to send humans into Orbit & ISS
- **2023** Tallest, most powerful rocket to ever launch

Government contracts totalling >$3bn

2008	$1.6bn	Deliver cargo to ISS	NASA
2012	$97m	Launch Deep Space Climate Observatory	US AIR FORCE
2012	$165m	Launch 2 satellites	US AIR FORCE
2016	$33m+	Raptor engine development	DOD
2020	$900m subsidies	Support rural broadband customers through Starlink	FCC
2021	$160m subsidies	Launches for US DoD	DOD
2022	$100m subsidies	Transport military cargo and humanitarian aid	US AIR FORCE

LAKE STAR (W)C Walden Catalyst dealroom.co

Europe must consistently review its legal framework to encourage innovation

Critics argue that the EU's extensive regulatory framework often leads to overregulation, stifling innovation and economic growth by imposing burdensome requirements on businesses.

While this narrative is certainly true in some areas (e.g., tax regulation), it is inflated in others (e.g., barriers to trade).

Nevertheless, in specific cases, the EU exhibits a more precautious and slower approach than the US. Legal frameworks that are adaptable to new digital business models lag behind.

Examples:

Autonomous Driving

Since 2018, China has standards to authorise L4 test AVs to circulate. Beijing and Shenzhen have authorised L4 autonomous taxi services. California approved circulation of test AVs. Waymo, based in Silicon Valley, is the leading L4 AV player by km tested, with close to 55% of the global total. In Europe, common legislation on L4 AVs is still under development.

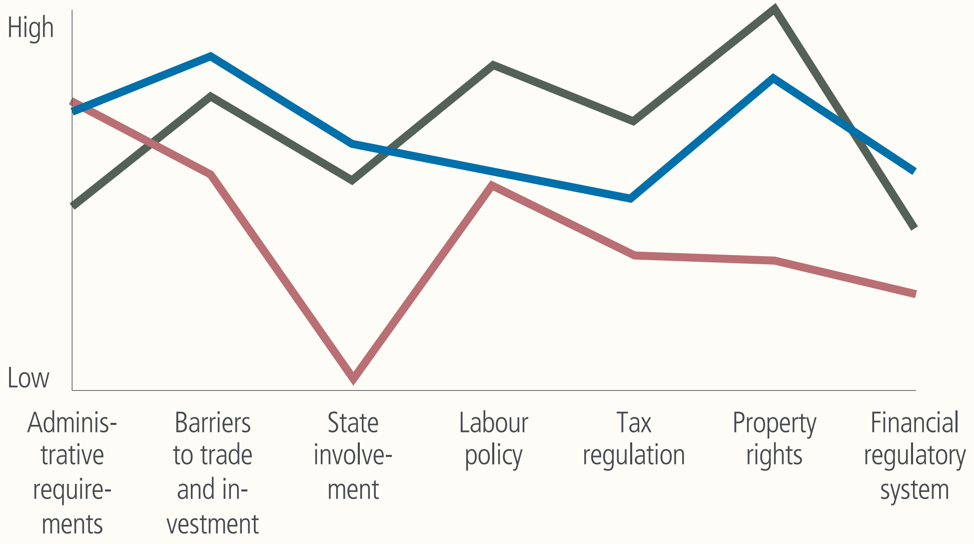
Biotech

The EU's General Data Protection Regulation (GDPR) includes specific provisions for the meticulous safeguarding of such data, whereas the US treats genomic data similarly to health data

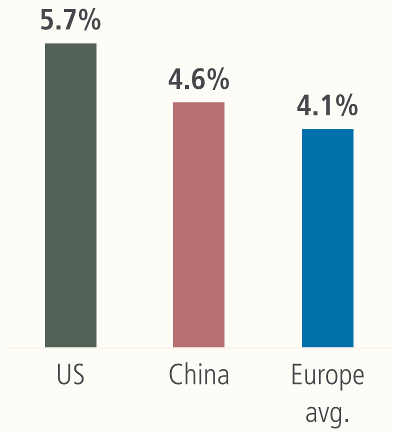
AI

The EU AI Act marks the world's inaugural concrete effort to regulate AI. Its objective is to transform Europe into a central hub for reliable AI by establishing unified regulations that oversee the creation, promotion, and utilisation of AI within the EU. The consequences of this act are still undetermined.

"Business friendliness" of regulatory domains



Adaptability of the legal framework to new digital business models[1]



1. Global competitiveness report 2019, World Economic Forum, October 2019.
Source: OECD 2018; EIU 2020; World Economic Forum; McKinsey Global Institute analysis

LAKE STAR
(W)C Walden Catalyst
dealroom.co

The EU is already channelling resources in this direction, but more needs to be done

“ Faced with the multitude of crises that we are experiencing today – the so-called polycrisis – it’s only natural that public policy makers are looking for solutions in areas that we haven’t looked before.

That’s where the Deep Tech sector is proving increasingly relevant, not only as an interesting business proposition, but also as the source of ground-breaking, disruptive solutions for many of the issues we are facing, from healthcare to security, climate change and environmental sustainability – and everything in between.

The EU is already channelling resources in this direction, but more needs to be done if we are to ensure European sovereignty in this field and overcome the current challenges, as many of the questions we are being asked will require very deep technological answers.

ROGER HAVENITH

DEPUTY CHIEF EXECUTIVE OF THE EIF

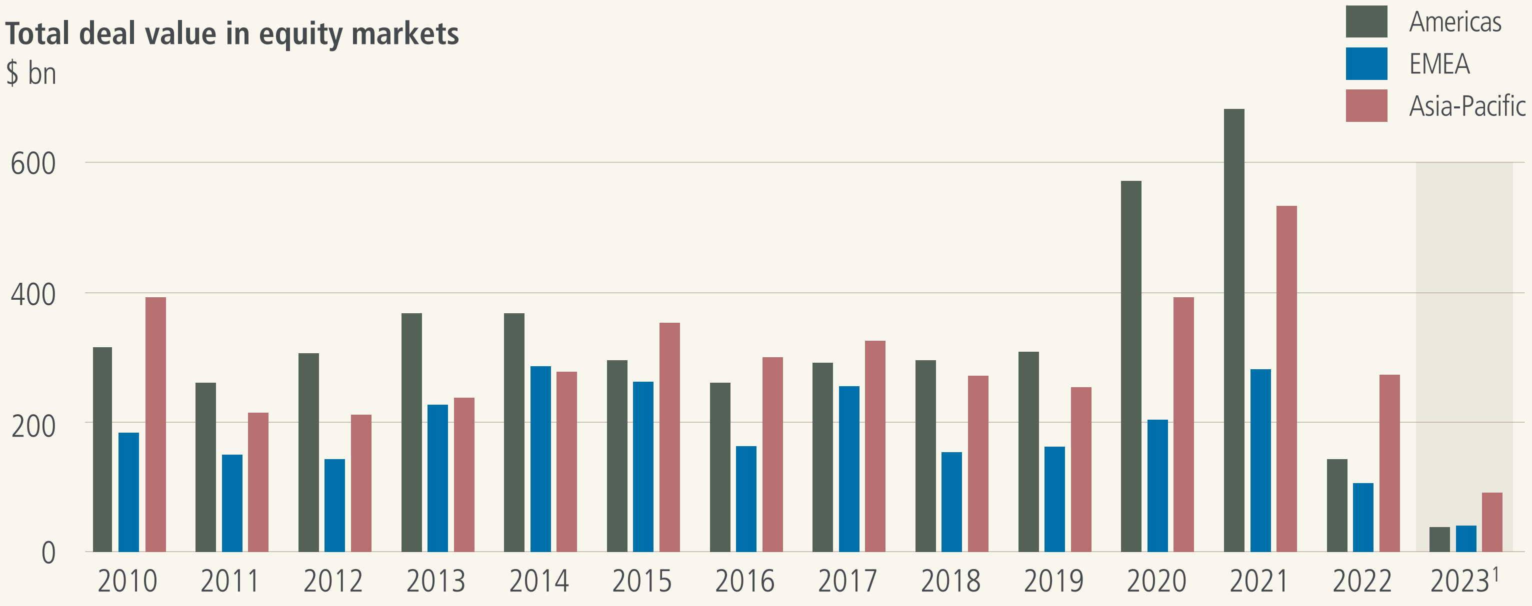
Europe needs a more harmonised approach to increase the attractiveness of its public markets

Europe's stock markets have a different market structure from the dynamic US market:

The fragmentation among European stock exchanges (Euronext, London Stock Exchange, Deutsche Börse) creates various liquidity pools and trading platforms.

Fewer active investors with significant financial resources, weaker analyst coverage and limited crossover investors weaken European market appeal.

Total deal value in equity markets
$ bn



1. 2023 is year to 24. AprilSource: FT.com, Dealogic

LAKE STAR

(W)C Walden Catalyst

dealroom.co

“We are in a good position to increase the attractiveness of the European capital markets. The recently adopted German Future Financing Act is a first important step to mobilise more capital and make IPOs more attractive. The envisaged EU Listing Act will support similar goals at the European level.

In addition, the Capital Markets Union would facilitate deeper and stronger European liquidity pools to support both equity investments in European private and public capital markets.

ERIC LEUPOLD

MANAGING DIRECTOR
CASH MARKET AT
DEUTSCHE BÖRSE AG

There is still a long way to go to achieve inclusion in European Deep Tech

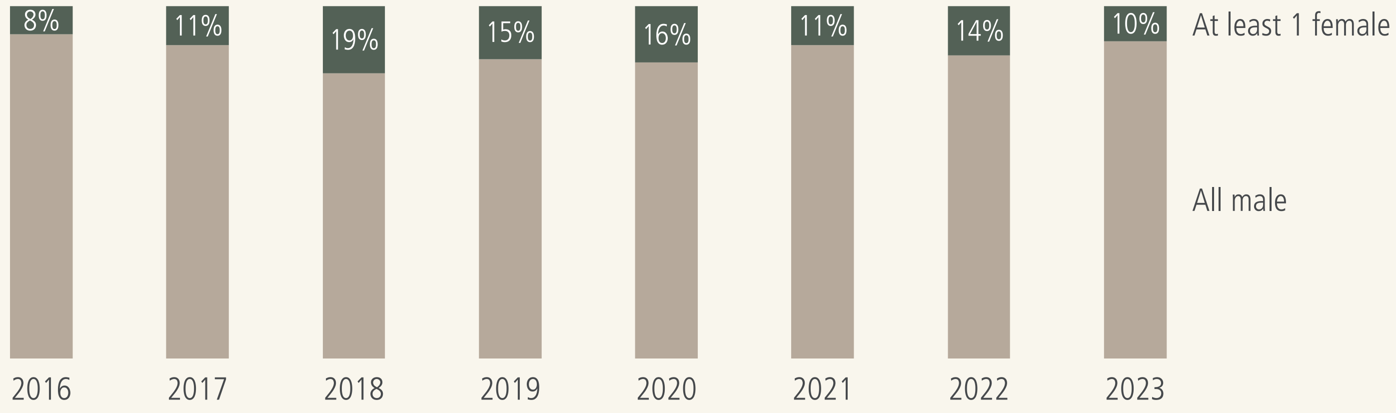
There are some promising female-founded Deep Tech startups emerging across Europe…

HUMANISING AUTONOMY | OQC | The Exploration Company | AQEMIA | CYLIB

…however, female founders remain underrepresented across Europe.

VC investment in European Deep Tech startups by founder gender

%



LAKE STAR | (W)C Walden Catalyst | dealroom.co

“This year we saw only 10% of VC funding going to European Deep Tech startups with at least one female founder.

This is down 29% from last year and is the lowest level we have seen in the past five years. Although the issue of diversity—both of gender as well as of background, race and experience—continues to be at the forefront of the industry, it’s clear that we are yet to see this translate into results.

Therefore, it’s vital that we continue to work together to improve these levels and create a more representative and fairer European ecosystem that is free from bias. After all, ensuring diversity of thought is essential for building a startup ecosystem that can truly prosper.

CHRISTINA FRANZESKIDES

DEEP TECH INVESTOR AT LAKESTAR

Recommendations

Encourage *more entrepreneurs* to move into Deep Tech

- Encourage a cultural shift towards embracing risk
- Drive collaboration between researchers and startups and establish university programmes that integrate technology and business, mirroring successful models like Stanford
- Attract more commercially-savvy and experienced operators
- Implement framework to attract talent back to Europe

Strengthen talent / excellence *clusters*

- Raise awareness for talent clusters to attract expertise into highly dense clusters for various technologies (e.g., Munich for space, Paris for AI, etc.)
- Foster a framework that encourages coopetition rather than fragmented competition for scarce talent, public funding, and private investment

Harmonise *spinout terms* and reduce bureaucracy

- Harmonise and standardise processes across Europe, drawing inspiration from the UK spinout review
- Streamline procedures to expedite the spinout process while minimising bureaucracy
- Establish proper incentives for Technology Transfer Offices (TTOs) across academia
- Implement a common framework for valuing intellectual property (IP)

Increase *LP base* and institutional investors

- Inform broader public about the asset class of Venture Capital and Deep Tech
- Shift assets from public to private, especially institutional investors to democratise returns (e.g., Tibi initiative in France)
- Remove regulatory hurdles to pave the way for a new asset allocation
- Create broad access, e.g., by lowering investment thresholds

Recommendations

Shift *governments and corporations* to become customers

- Design right framework where public entities and corporates have to involve startups (e.g., corporates should consider startups in their procurement process)
- Highlight the benefits for public institutions and corporates of being a customer vs. project managers
- Stress the importance and benefits of commercial contracts for companies over grants

Strengthen *exit channels / public markets*

- Promote the Capital Markets Union to strengthen European liquidity pools
- Adopt regulations to foster harmonisation and unification (e.g., EU Listing Act), including for secondary liquidity (e.g., Forge Europe)

Review innovation *regulation*

- Tie regulation and corporate responsibility to size of the company to not stifle early innovation ("stronger shoulders can carry more")
- Install pan-European ESOP legislation as demanded by ESNA, mirroring new models like in Germany
- Review & harmonise legal frameworks across Europe on an ongoing basis (e.g., how to set up a company)

Promote *diversity*

- Promote diversity across founders & investors
- Stress importance of education, equal opportunity, and offer support to ensure individuals have the necessary resources for success
- Shine light on role models

LAKE STAR

(W)C Walden Catalyst

dealroom.co