BCG BOSTON CONSULTING GROUP

hello tomorrow

The Dawn of the Deep Tech Ecosystem

Journalist Exclusive Content Release

EMBARGOED UNTIL 1PM CET ON 14 MARCH 2019

BCG and Hello Tomorrow Deep Tech Publication

First Abstract Release

"The report is based on in-depth interviews, market research, examinations of funding, patent and publication data, and a survey of more than 2,000 startups from the Hello Tomorrow Challenge, which assesses deep tech startups on four criteria: technological innovation, business model, team skills, and expected impact.

The report examines seven fields of deep tech endeavor and the roles of multiple types of deep tech ecosystem participant.

We take a tour of the evolving deep tech ecosystem and offer some observations on how the different types of participants can maximize the value of their efforts. If indeed we are on the cusp of a new era in technology R&D, we set the stage for what is to come and, in particular, how corporations, investors, and startups need to think about their roles in the future."

Agenda

1. Meet the new breed of deep tech startups — *Slides: 4-11*
2. Deep tech is on the rise globally — *Slides: 12-20*
3. R&D is changing — *Slides: 21-25*
4. China and the US are leading the deep tech race — *Slides: 26-28*
5. Focus on France — *Slides: 29-39*

1. Meet the new breed of deep tech startups

Deep Tech definition and characteristics

Novelty

Deep technologies are novel and offer significant advances over technologies currently in use.

They require significant R&D to develop practical business or consumer applications and bring them from the lab to the market

Impact

Many of these technologies address big societal and environmental challenges and will likely shape the way we solve some of the most pressing global problems.

These technologies have the power to create their own markets or disrupt existing industries

Time & Scale

Deep tech takes time to move from basic science to a technology that can be applied to actual use cases.

The amount of time varies substantially by technology but it is almost always longer than an innovation based on a widely available technology would take, and can be more than 10 years.

Investment

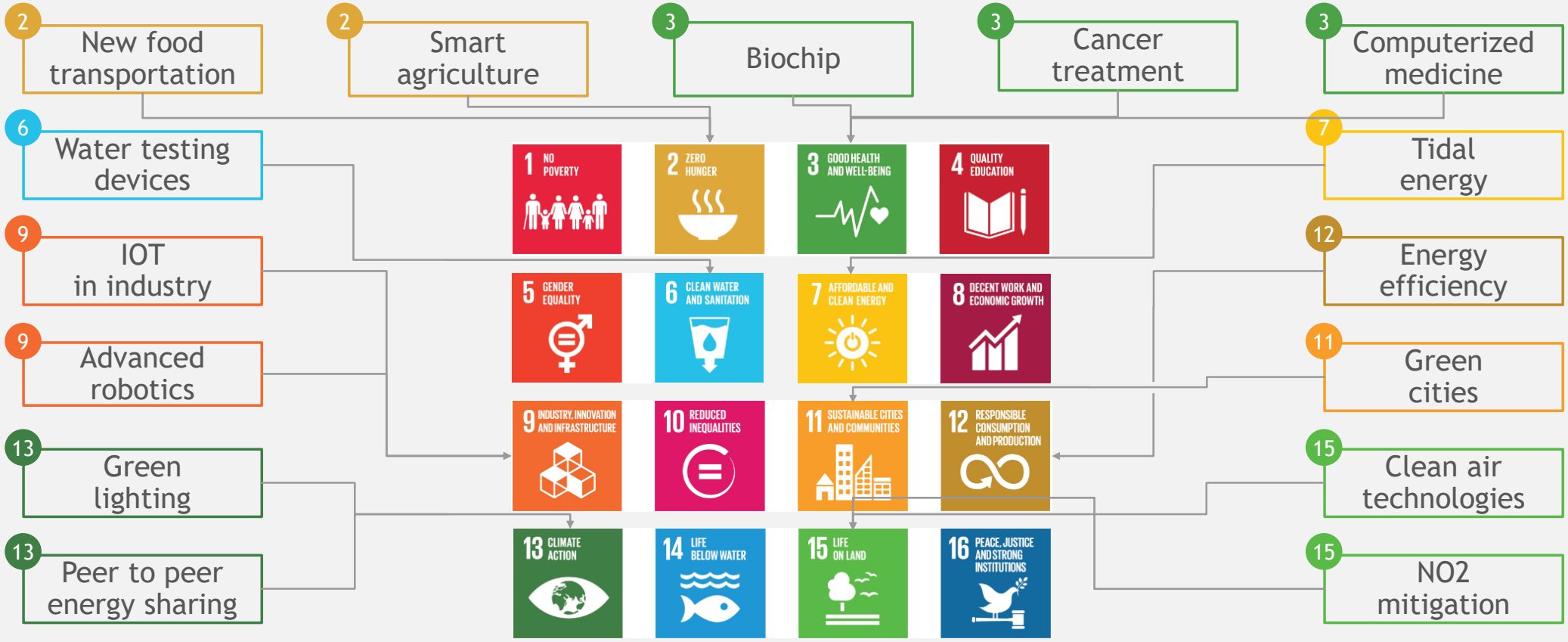
Continuous investment from ideation through commercialization and intensive capital requirements, complicated by the technology risk adding to the market risk.

Generally requires both public and private funds & resources for full development

Source: BCG and Hello Tomorrow analysis

Deep Techs Will Help to Solve Most of the Environmental and Societal Challenges

Illustration of UN SDGs where deep techs are involved

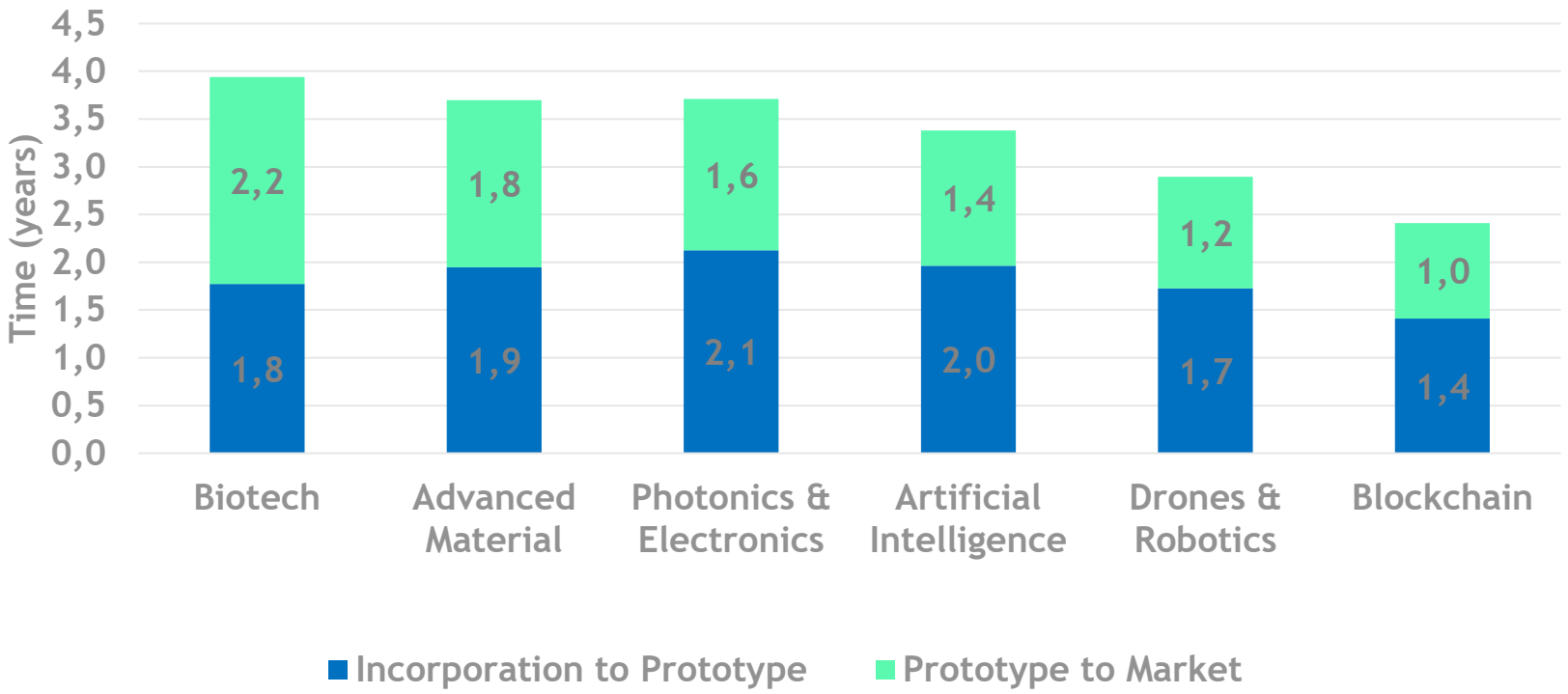


Deep Tech "Impact": Share of Deep Tech Startups Targeting Each UN Sustainable Development Goal

SDG	Number	Share
Good health and wellbeing	837	51%
Industry, innovation and infrastructure	827	50%
Sustainable cities and communities	469	28%
Responsible consumption and production	413	25%
Climate action	369	22%
Decent work and economic growth	340	21%
Affordable and clean energy	289	18%
Reduced inequalities	231	14%
Clean water and sanitation	165	10%
Life on land	160	10%
Quality education	160	10%
Zero hunger	156	9%
No poverty	137	8%
Gender equality	100	6%
Peace, justice and strong institutions	95	6%
Life below water	79	5%
Total Number of Qualified Startups	1646	100%

Source: 1,646 deep tech startups of the Hello Tomorrow Challenge in 2018, Hello Tomorrow analysis

Deep Tech "Time & Scale": The Average Time Required from Incorporation to Market Varies for Each Deep Tech Category



Note: does not take into account the time for research before incorporation
Source: 1,500 startups (500 best startups from the Hello Tomorrow Challenge in 2016, 2017, and 2018), Hello Tomorrow analysis

Deep Tech "Time & Scale": Example of Facebook VS Lilium Aviation - winner of the Hello Tomorrow Challenge in 2016

Facebook : 20 months

January 2004
IDEA

February
LAUNCH OF "THE FACEBOOK" AT HARVARD

March
EXPANDS TO STANFORD, COLUMBIA & YALE

August
INCORPORATION

Sep. 2005
SPREADING WORLDWIDE

Lilium Aviation : 12 years

2013
IDEA IN GLASGOW

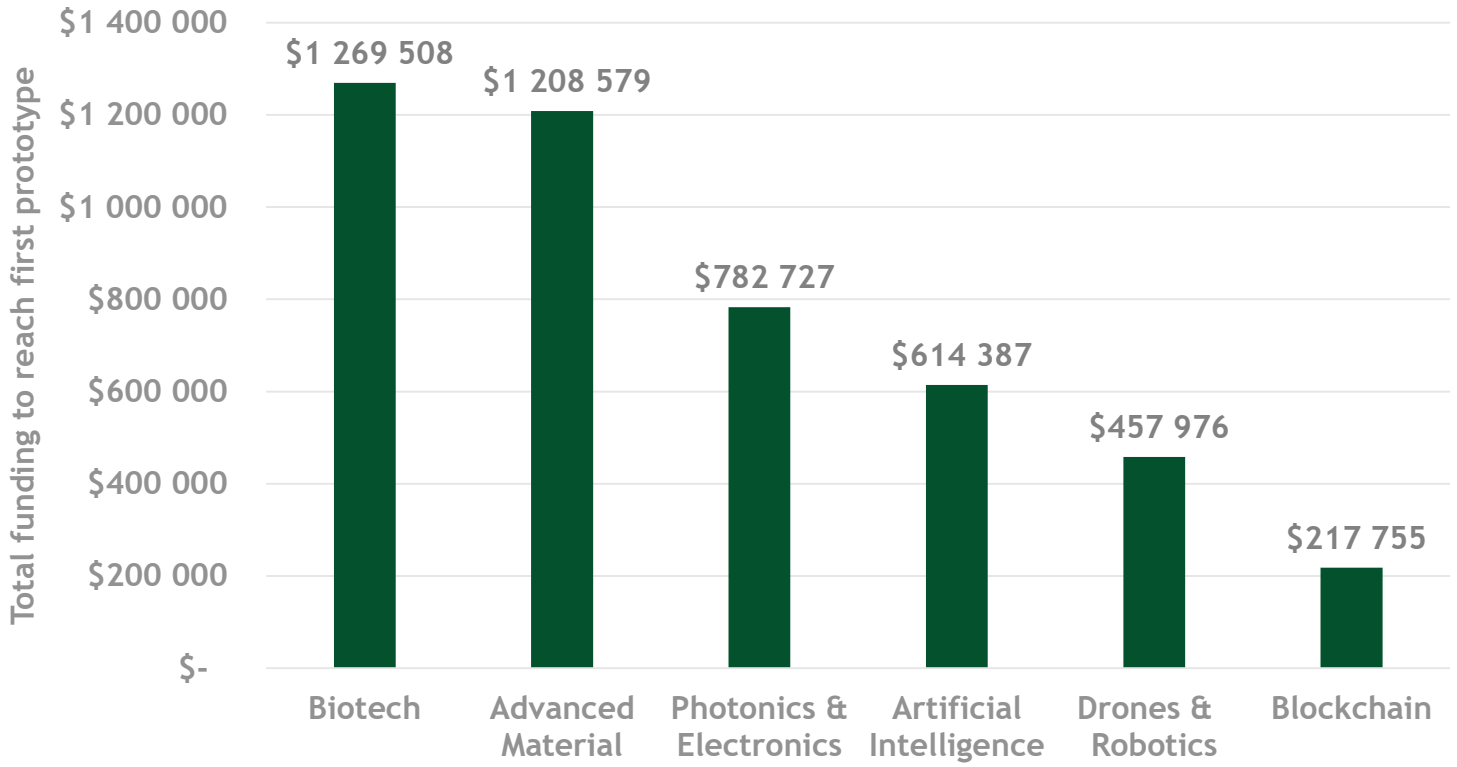
2015
FLIGHT OF THE FALCON

2017
TEST FLIGHT OF FULL-SIZED PROTOTYPE

2019
FIRST MANNED FLIGHT

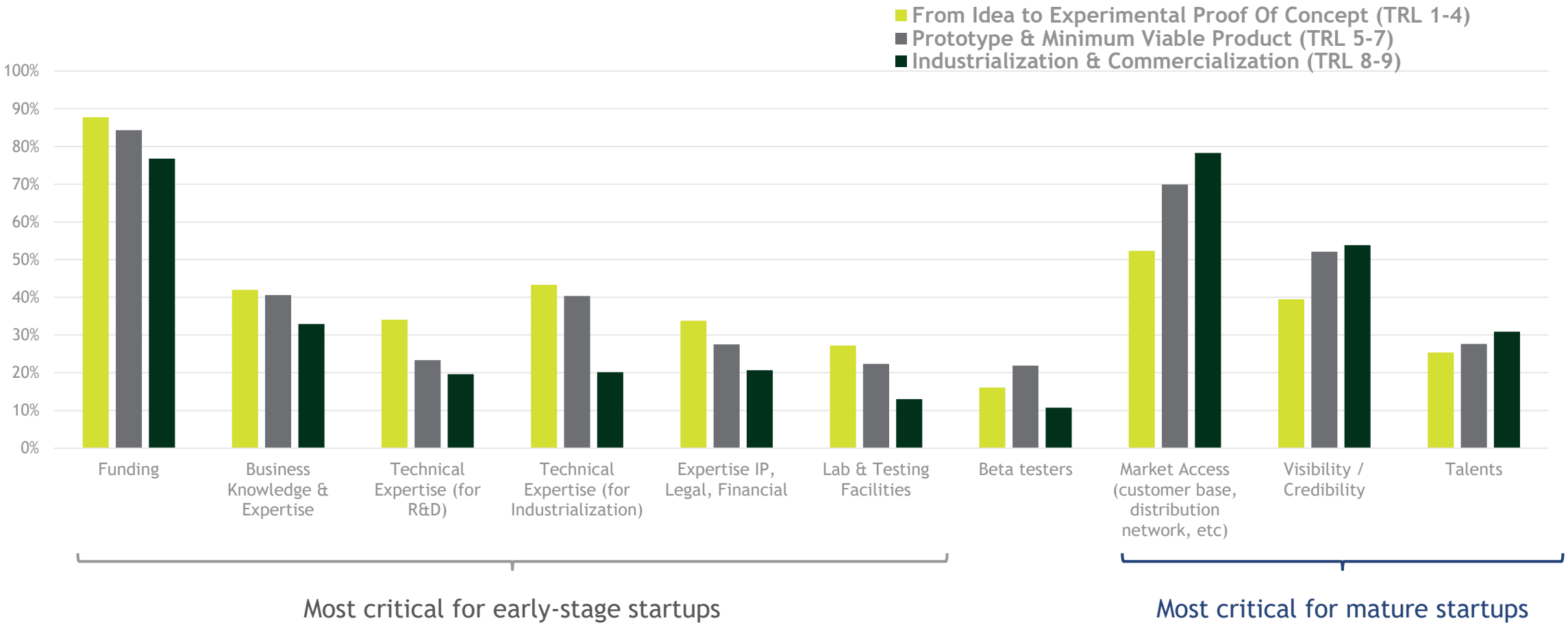
2025
YOU CAN BOOK A LILIUM JET

Deep Tech "Investment": The Average Total Funding (Equity and Non-Equity) Required To Build the First Prototype (TRL 5) Varies by Technology



Note: TRL 5 = technology readiness level 5 on NASA-originated scale of 1 to 9. At TRL 5, the technology has been validated in a simulated or real-world environment.
Source: 1,500 startups (500 best startups from the Hello Tomorrow Challenge in 2016, 2017, and 2018), Hello Tomorrow analysis

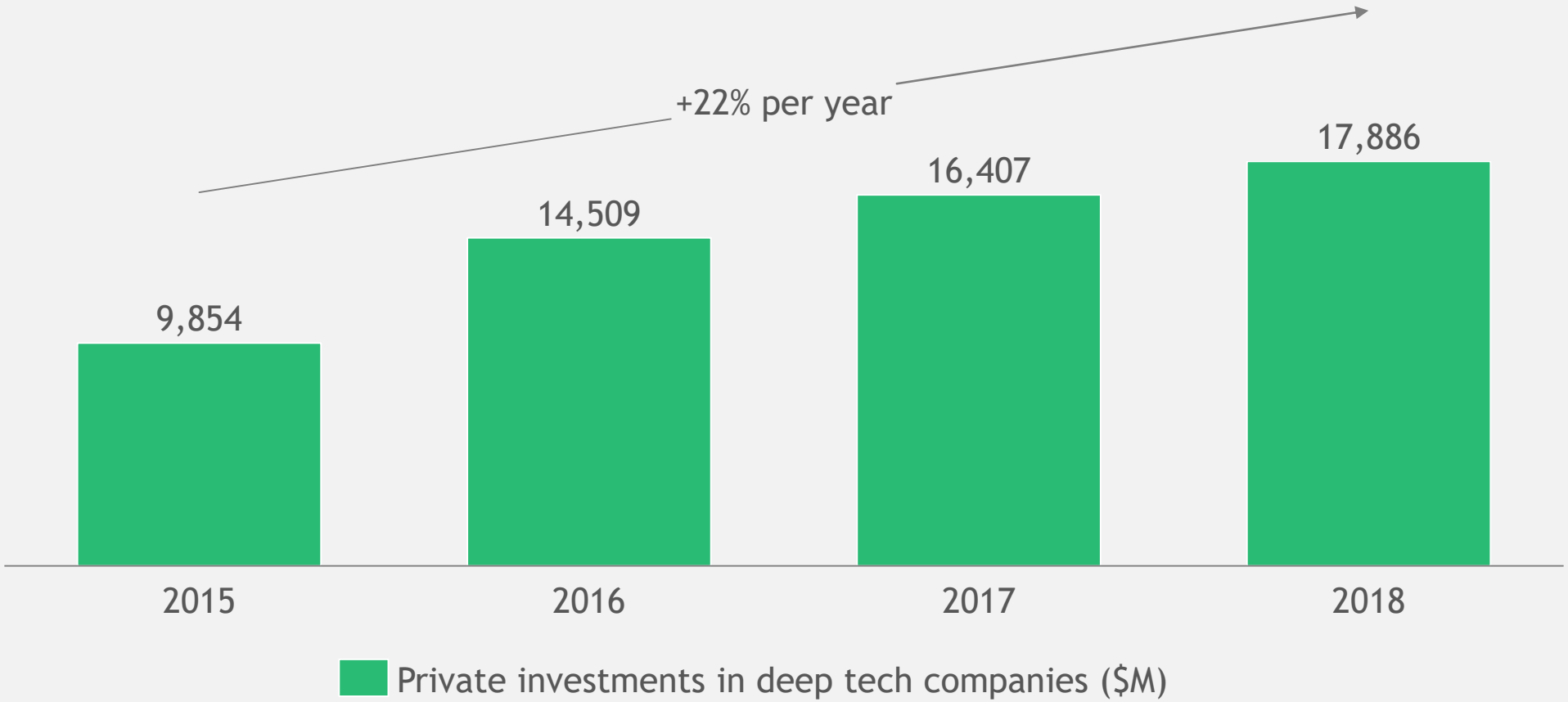
Deep Tech Startups' Most-Needed Resources Evolve with the Company's Maturity



TRL= technology readiness on NASA-originated scale of 1 to 9.
Source: 1,646 deep tech startups qualified for the second round of the Hello Tomorrow Challenge in 2018 (from 4,500 applications), Hello Tomorrow analysis

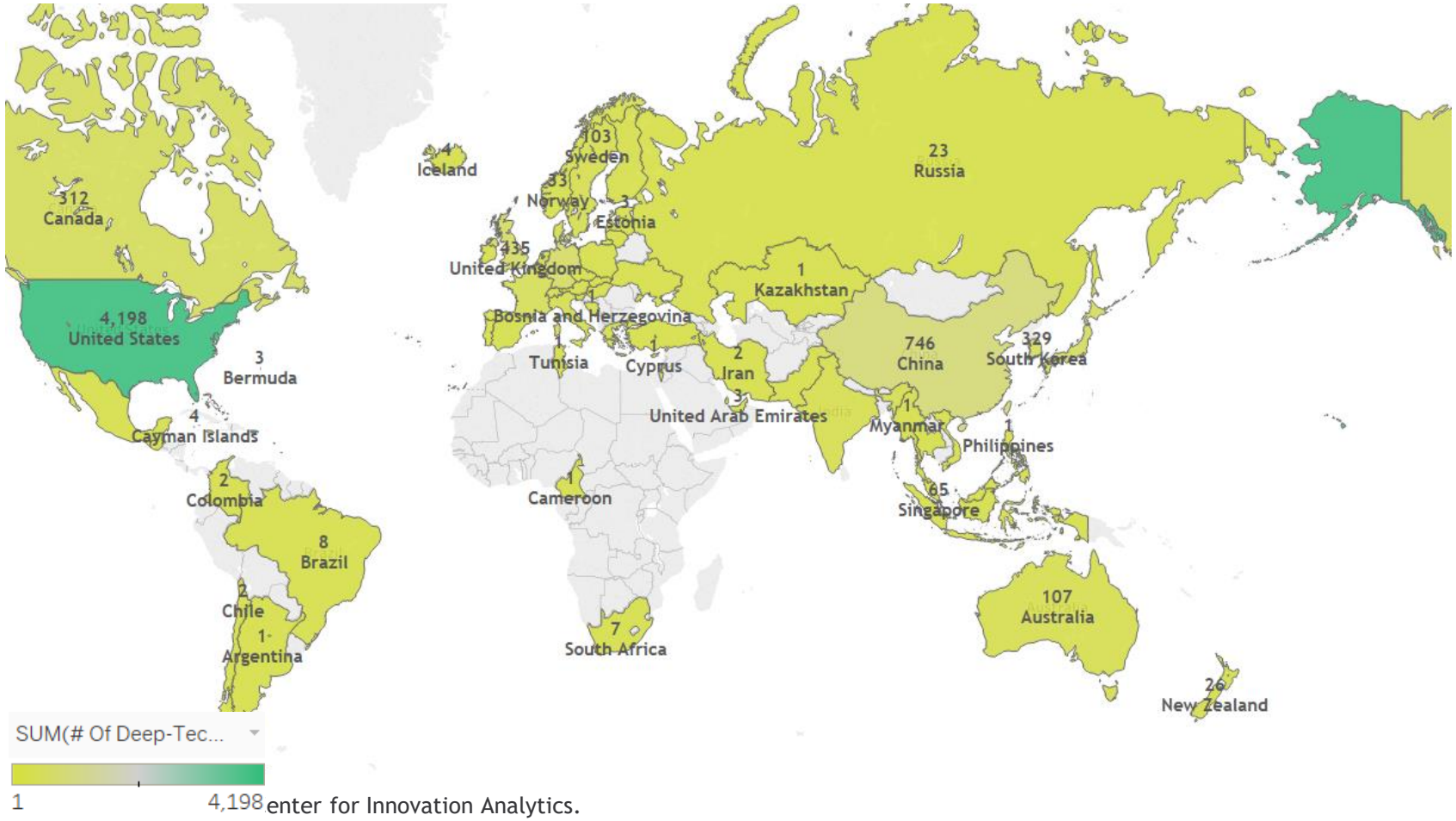
2. Deep tech is on the rise globally

Global Private Investments In Deep Tech Have Soared



Includes investment in seven deep tech categories: advanced materials, artificial intelligence, biotechnology, blockchain, drones and robotics, photonics and electronics, and quantum computing. Private investment sums are based on transactions with disclosed amounts. Some 41% of private investments in deep tech companies remain undisclosed.
Source: Capital IQ, Quid, BCG Center for Innovation Analytics

Deep Tech Is a Global Phenomenon: ~8,600 Companies in ~70 Markets



enter for Innovation Analytics.

Note: Analysis is based on 8,682 deep tech companies related to 16 technologies across seven categories: advanced materials, artificial intelligence, biotechnology, blockchain, drones and robotics, photonics and electronics, and quantum computing. Exhibit is missing geographic information for 199 companies. Greater China includes mainland China, Hong Kong, Macau, and Taiwan.

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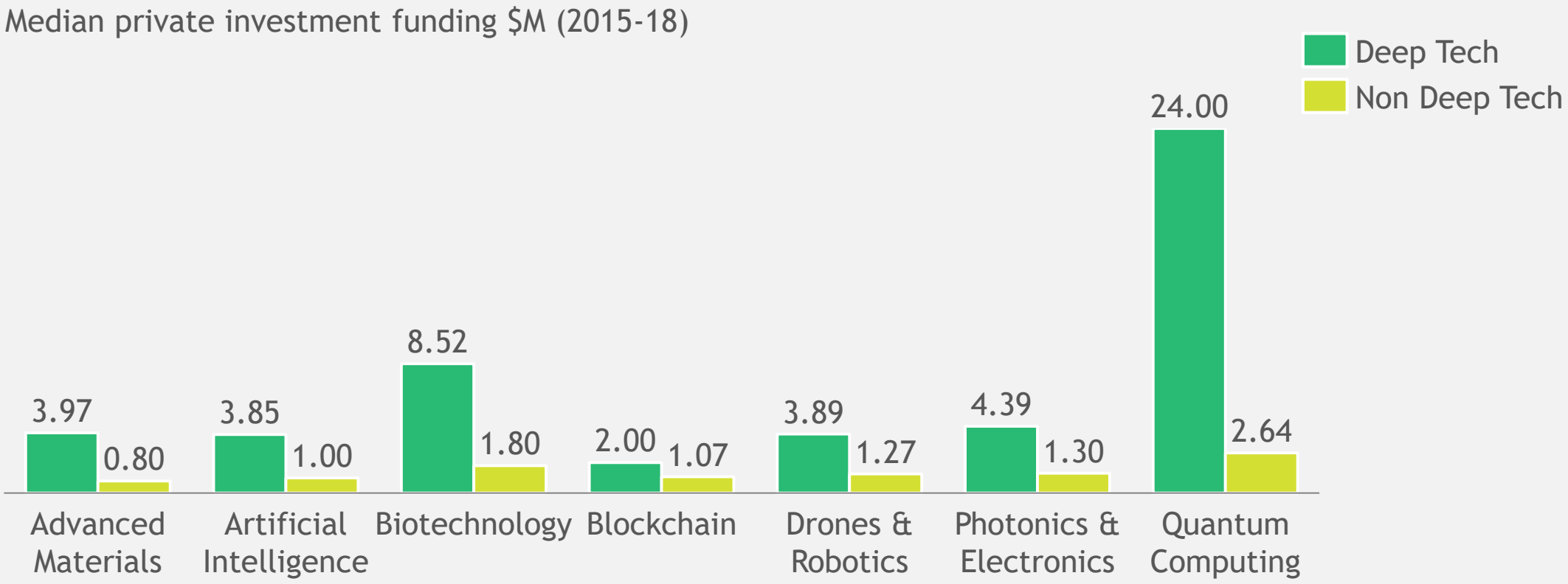
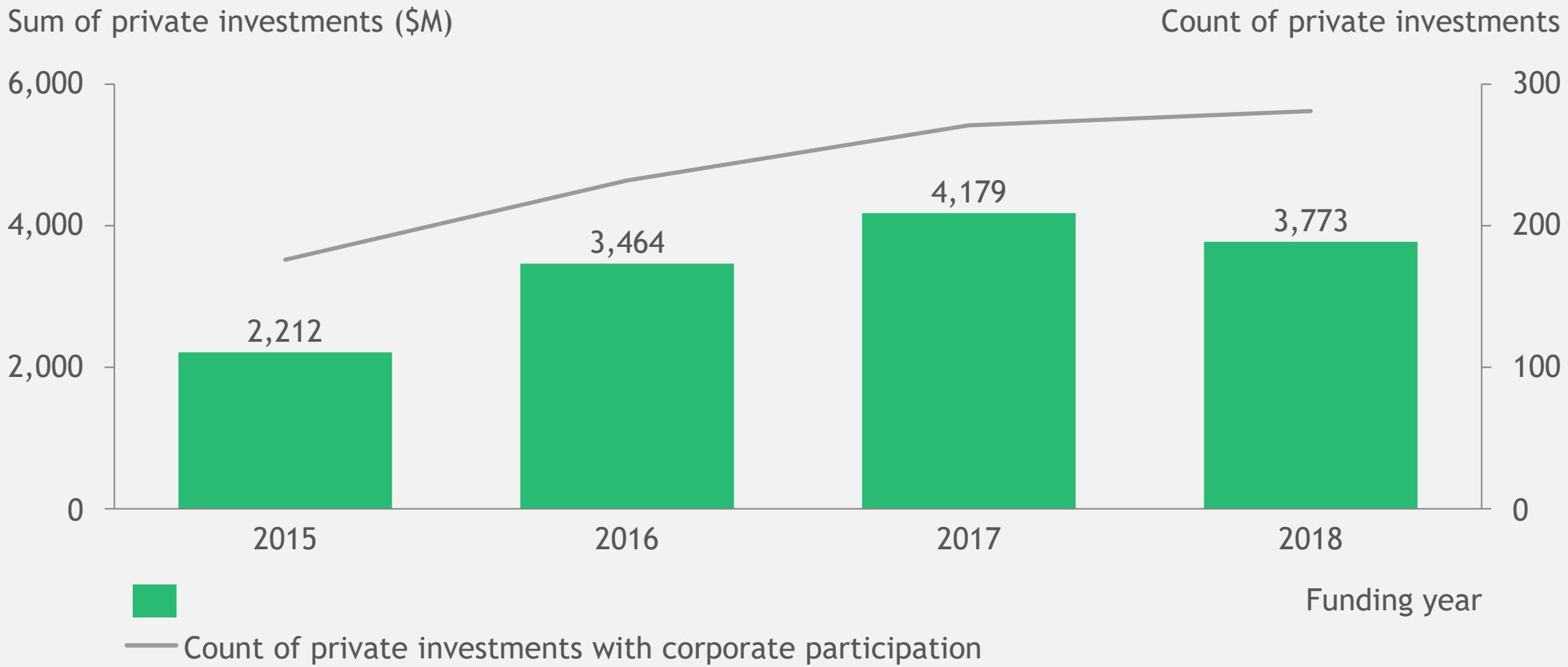
United States (4198)
Greater China (746)
Germany (455)
United Kingdom (435)
Japan (363)
South Korea (329)
Canada (312)
France (241)
Israel (195)
Switzerland (147)
India (129)
Australia (107)
Sweden (103)
Netherlands (78)
Italy (70)
Spain (66)
Singapore (65)
Denmark (59)
Finland (41)
Belgium (41)
Ireland (39)
Austria (35)
Norway (33)
New Zealand (26)
Russia (23)
Poland (20)
Portugal (10)

Deep Tech Companies Attract More Private Investment than Others



Note Quantum computing has only 8 deep tech companies, with two raising a combined $64 million in 2016 and 2017.
Source: Capital IQ, Quid, BCG Center for Innovation Analytics

Corporate Investing in Deep Tech Startups Rising



Includes investment in seven deep tech categories: advanced materials, artificial intelligence, biotechnology, blockchain, drones and robotics, photonics and electronics, and quantum computing.
Source: Capital IQ, Quid, BCG Center for Innovation Analytics

What is Driving Deep Tech Rise?

1

The Rise of New Platform Technologies

2

Falling Barriers of Entry

3

Growth in Available Capital

Source: BCG and Hello Tomorrow analysis

1/ Deep Tech is the Next Stage of Continuous Progress in Platform Technologies

Chips & Computers
1960s-70's

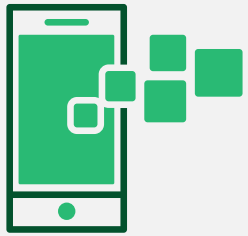
Silicon chips enabling modern day computing

Desktop computers

Internet
1980s-90's

Processing power enabled new level of advancements

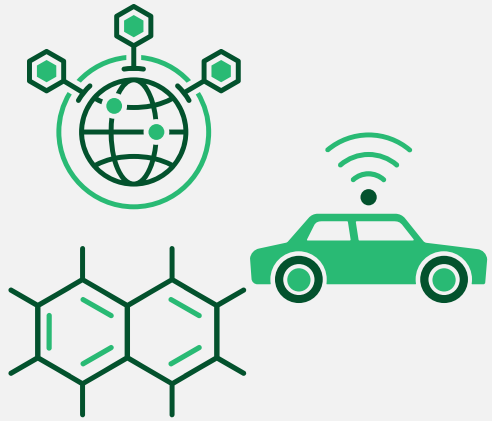
Global instantaneous connectivity



Digital & Mobile
2000's - Present

Available all the time, everywhere

Information spreads like wildfire



Deep Technologies
2010 – Future

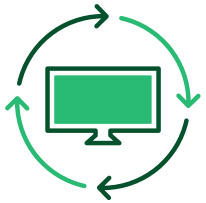
Giving more and more autonomy to machines, and engineering life at a large scale

Impact on industries and society still hard to fathom

Source: Pew Research Center; Science & Technology Facilities Council; BCG and Hello Tomorrow experience

2/ Barriers to Entry have Significantly Decreased to Enter Cutting-edge Research

Data



Open IP environment
AI algorithms are public, TESLA making patents available; Microsoft settling with Linux and joining the community

Ease of access to information
Internet, 65-70% of global population owns a cell phone

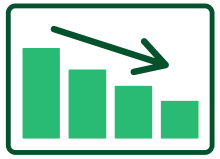
More data available
90% of global data was generated in last two years; 66% by consumers

Software and Computing

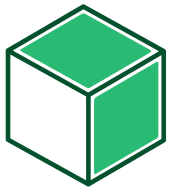
Progress in ML/AI
Virtualization of research

Increase of computing power
AWS; essentially exponential growth in power

Hardware



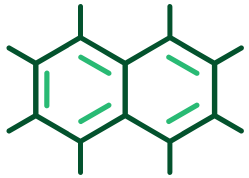
Decrease in overall cost of hardware



Easier access to 3D printing
From home to industrial, more reliable, more materials, millions of free designs

Increase in use of IoT
10 to 50 devices p.p. from 2016-2022

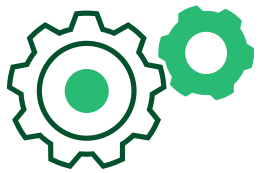
Biology



Gene sequencing and editing as a service

Process

Increase of interdisciplinary research and applications

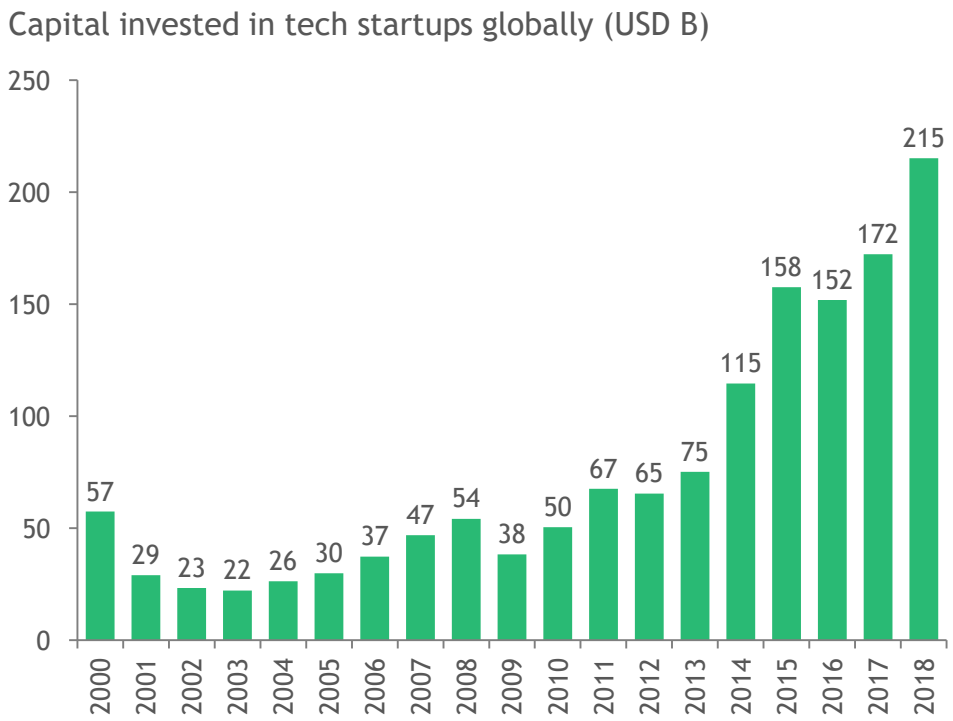


Dissemination of open innovation practices

Source: Expert interviews; BCG and Hello Tomorrow analysis

3/ Capital Investment in Startups Continuously Expanding

Historic investment in tech startups



Current trends of increased capital deployment in tech fields

~30%
Increased capital invested in European startups
5-yr CAGR
12-17

37%
Non-tech corp. investing in European tech
5-yr CAGR
12-17

~20%
Increased deal flow in European startups
5-yr CAGR
12-17

20%
Increased number of unique investors
5-yr CAGR
12-17

With such growth in AuM expected, anticipation of continued and expanded investment in "other types of investments" (i.e. startups)

Source: Pitchbook; Dealroom; BCG analysis

3. R&D is changing

BCG and Hello Tomorrow Deep Tech Publication

First Abstract Release

"Is the shape of technology R&D changing?

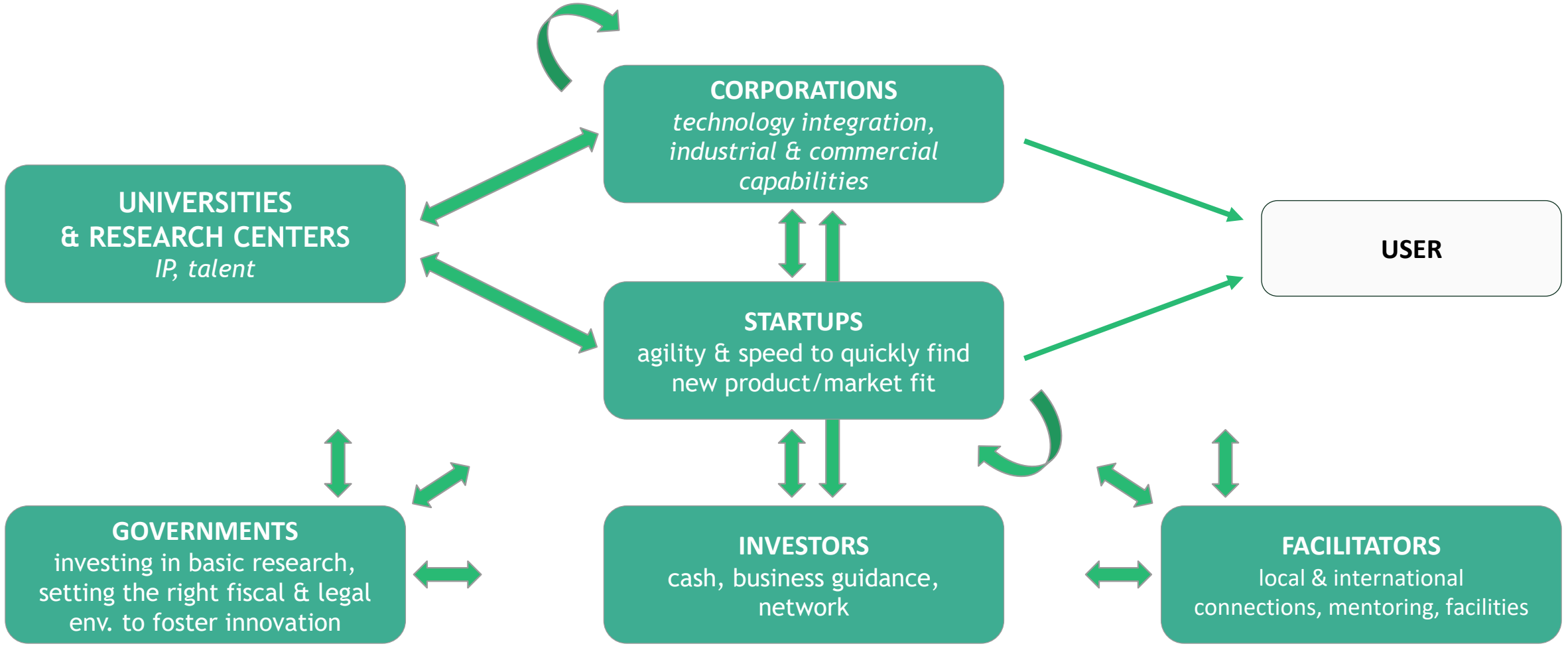
Is a new model emerging for developing and commercializing deep technologies — novel technologies that still require some advances to be market ready but from which enormous impact is expected?

Are the central roles with respect to the development of new scientific discoveries and their transfer to commercial applications traditionally played by large entities and institutions—corporations, governments, universities and others—being increasingly augmented, and in some instance replaced, by startups?

Do the many stakeholders with a basic interest in technology R&D need to rethink how they play the game?

The overarching answer to all these questions is, yes."

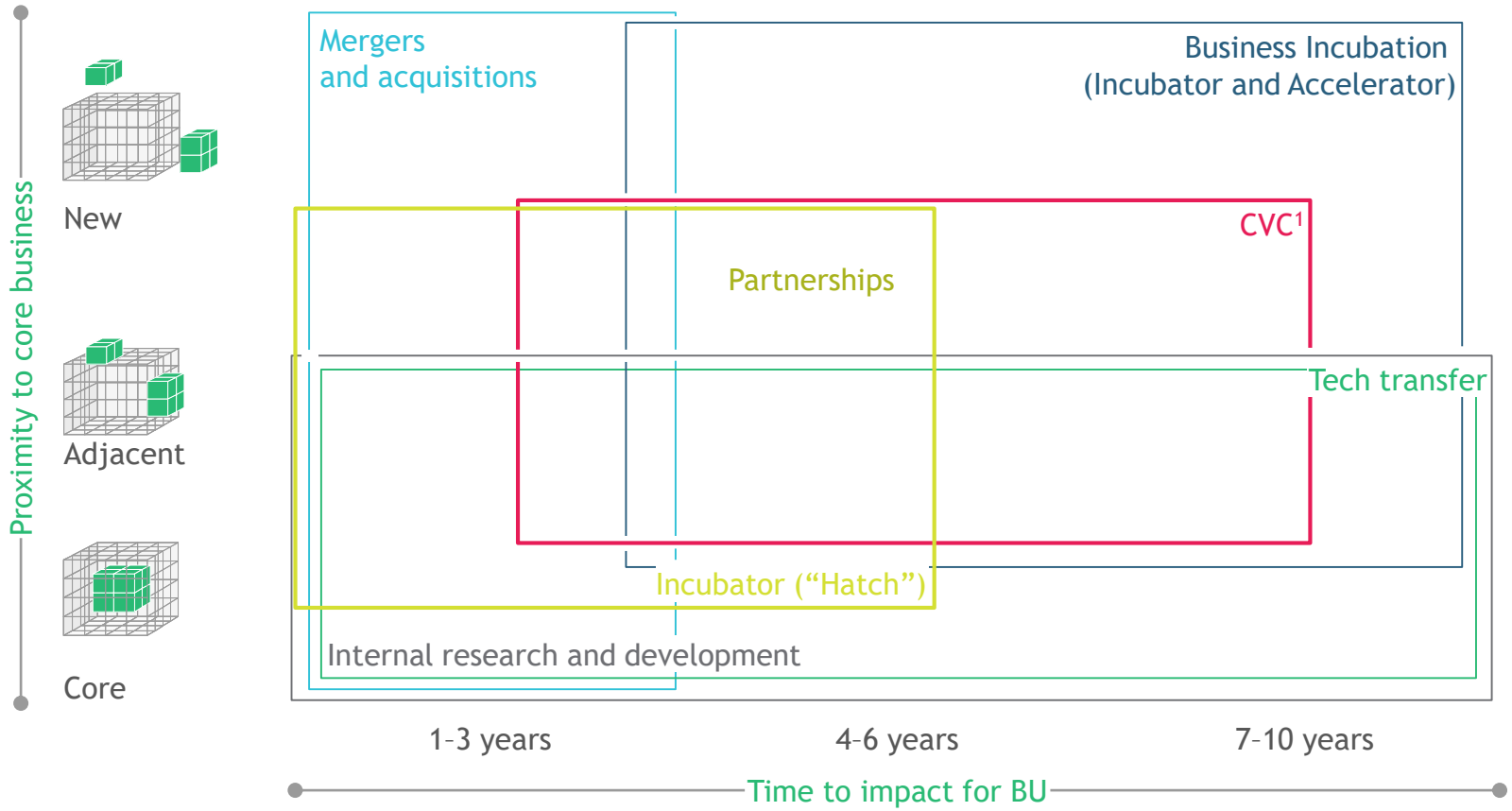
The Deep Tech Ecosystem Encompasses Diverse Types of Actors



Source: Hello Tomorrow analysis

Increased Sophistication Towards Innovation from Corporations

Strategic objectives of internal and external innovation units



Description

CVC[1]
Equity investments to assess and access new growth opportunities

Incubator ("Hatch")
Create new and sustainable business models along a structured approach

Business Incubation
(Incubator and Accelerator)
Support of and cooperation with start-up companies in early stages

Tech Transfer
Scouting/identification and transfer of innovation/technology by external sources into corporate (e.g., IP licensing)

Strategic partnerships
Partnerships/joint ventures that drive incremental revenue for BU

Mergers & Acquisitions (M&A)
Acquisition of developed companies with existing business

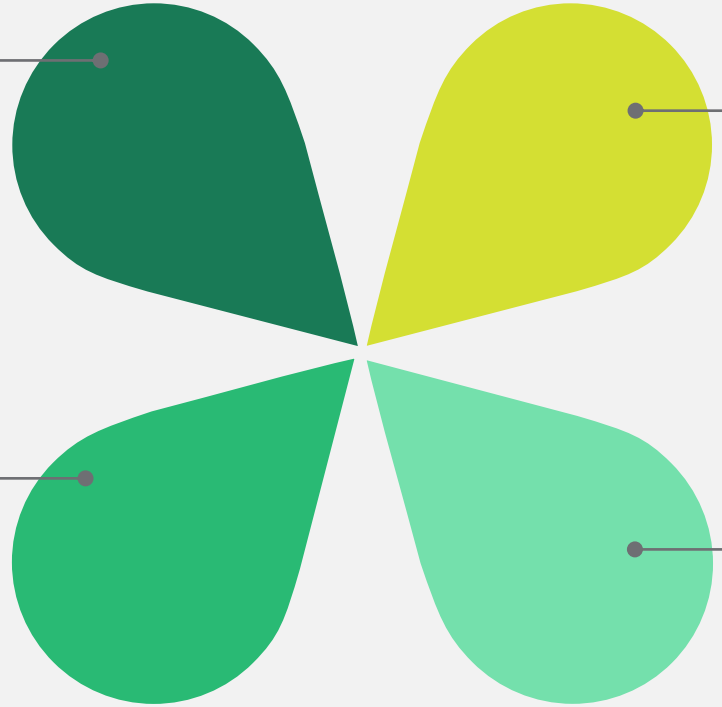
Internal Research and Development
Internal product development

1. CVC=Corporate Venture Capital
Source: BCG analysis

Ecosystems' 4 Main Dynamics

Multi-entity

- More types of players (startups, corporations, investors, universities & research centers, governments, facilitators)
- More diverse sources of players (public and private sector)



Horizontal and Decentralized

- Rarely a controlling party
- Each party can influence the direction of the whole
- Orchestrator more like a magnet than a manager
- Ecosystem development is driven by aligning visions, knowledge and goals

Dynamic Structures and Relationships

- Often informal relationships
- Emerging relationships & changing roles of players based on changing needs

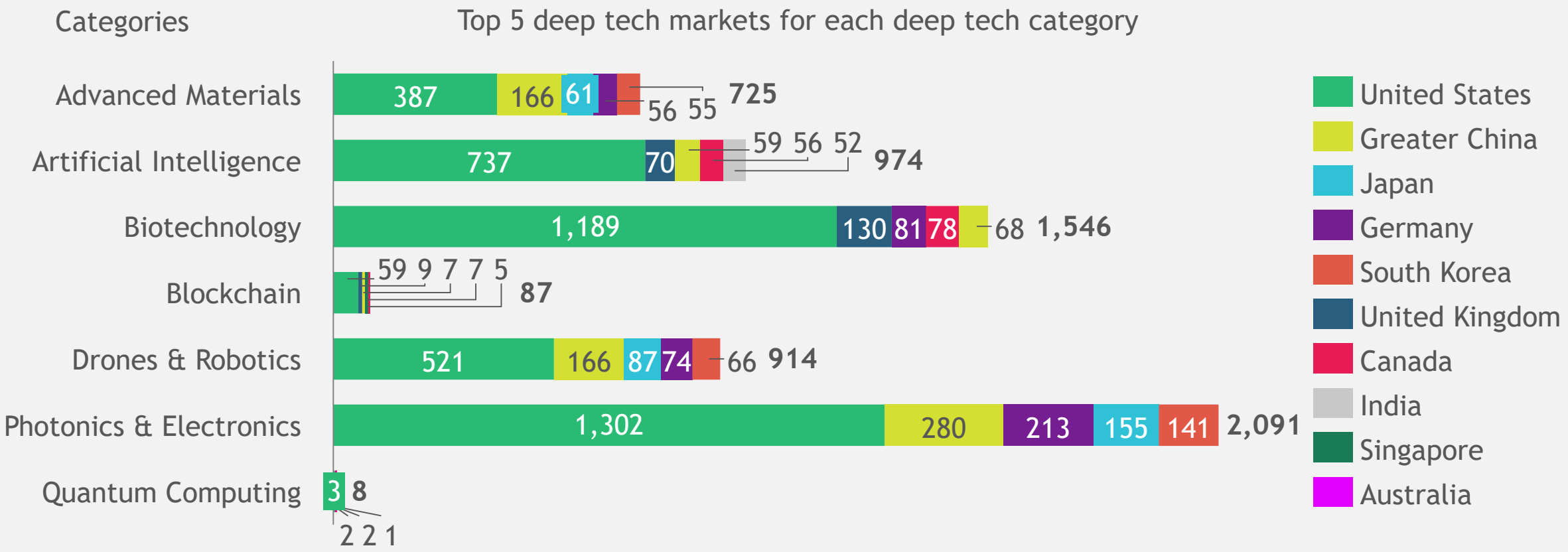
Non-financial Linkages

- Financial gains (ROI) are important but often not the focus of the relationships
- Including also: knowledge, data, skills, expertise, contacts, market access (and cash)
- Assessing value is different than traditional relationships: ROI takes a back seat to larger goals

Source: BCG and Hello Tomorrow analysis

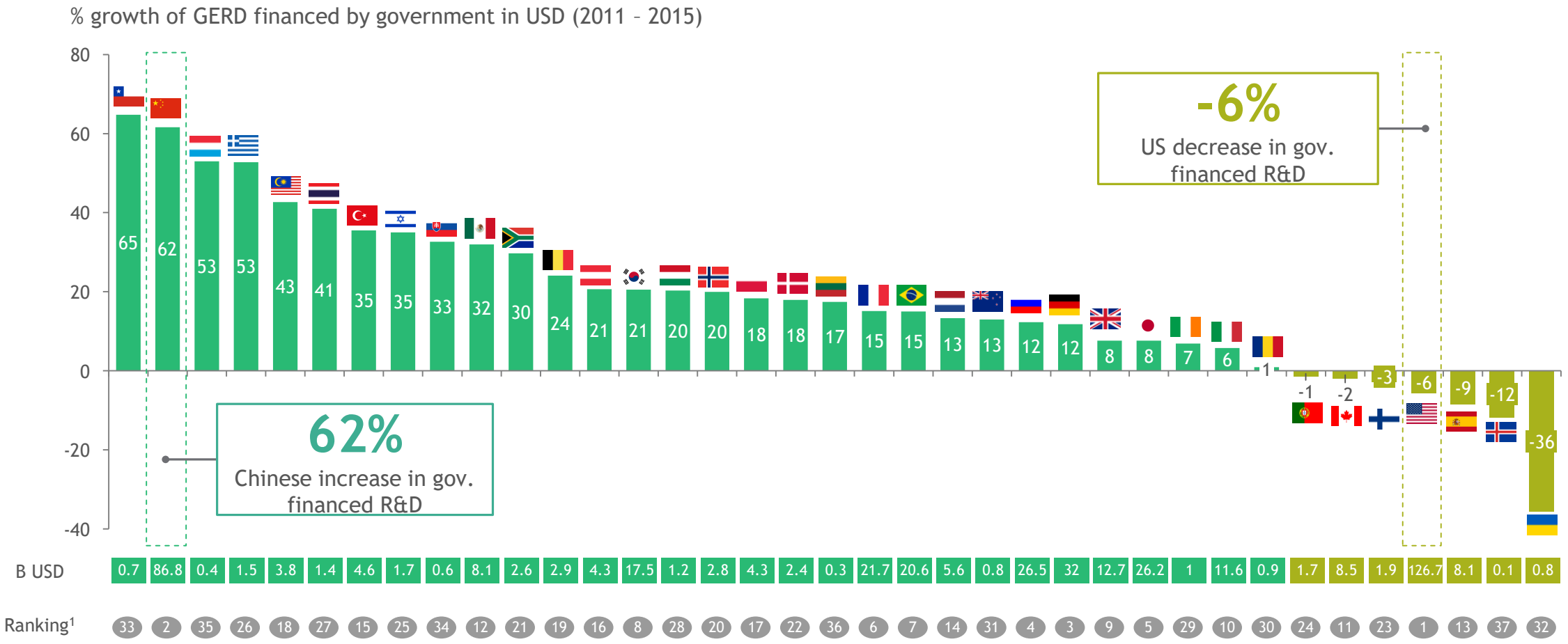
4. China and the US are leading the deep tech race

The US Leads as a Deep Tech Hub, but Considerable Activity Is Occurring Elsewhere



Sources: Capital IQ; Quid; BCG Center for Innovation Analytics.
Note: Greater China includes mainland China, Hong Kong, Macau, and Taiwan.

Chinese Government is Putting Considerable Efforts into R&D to Catch Up

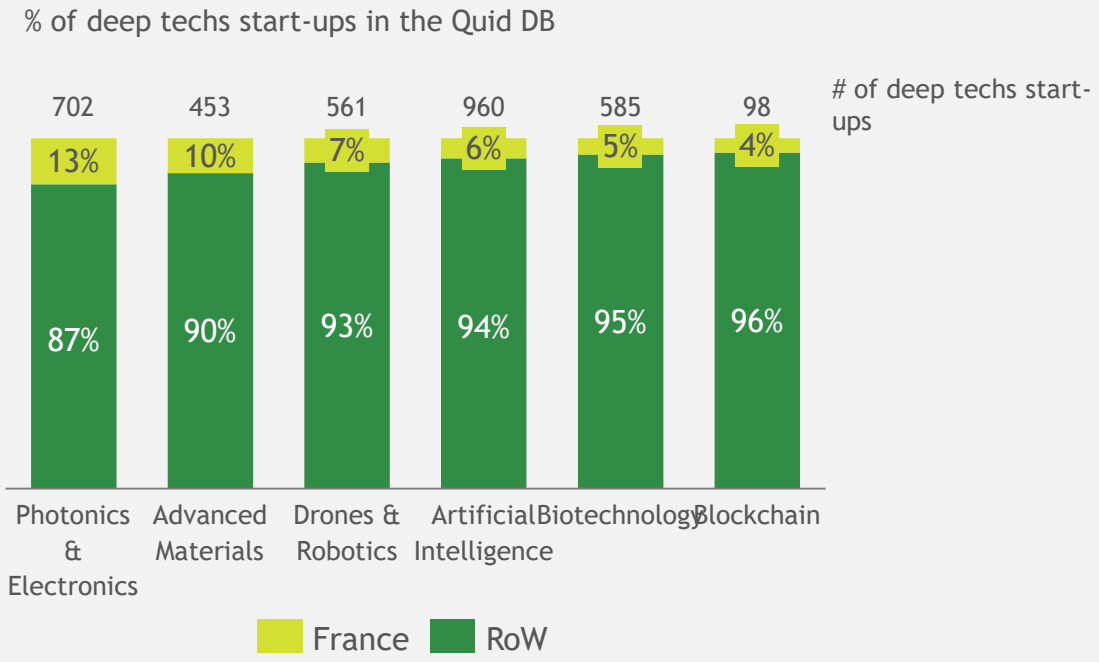


1. Ranking relative to current list of countries
Note: Gross domestic expenditure on R&D (GERD)
Source: UNESCO GERD data collection; BCG analysis

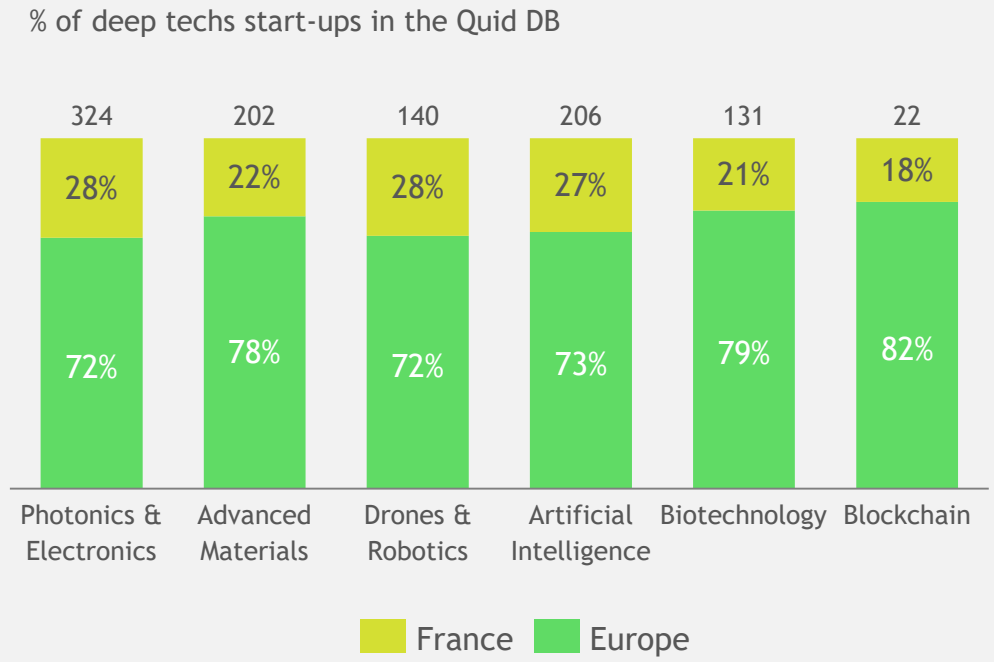
5. Focus on France

In this Deep Tech Environment, France Has a Strong Presence in Photonics & Electronics and Adv. materials

France has a strong presence in photonics & electronics..



.. and it's even stronger in other fields at the European level

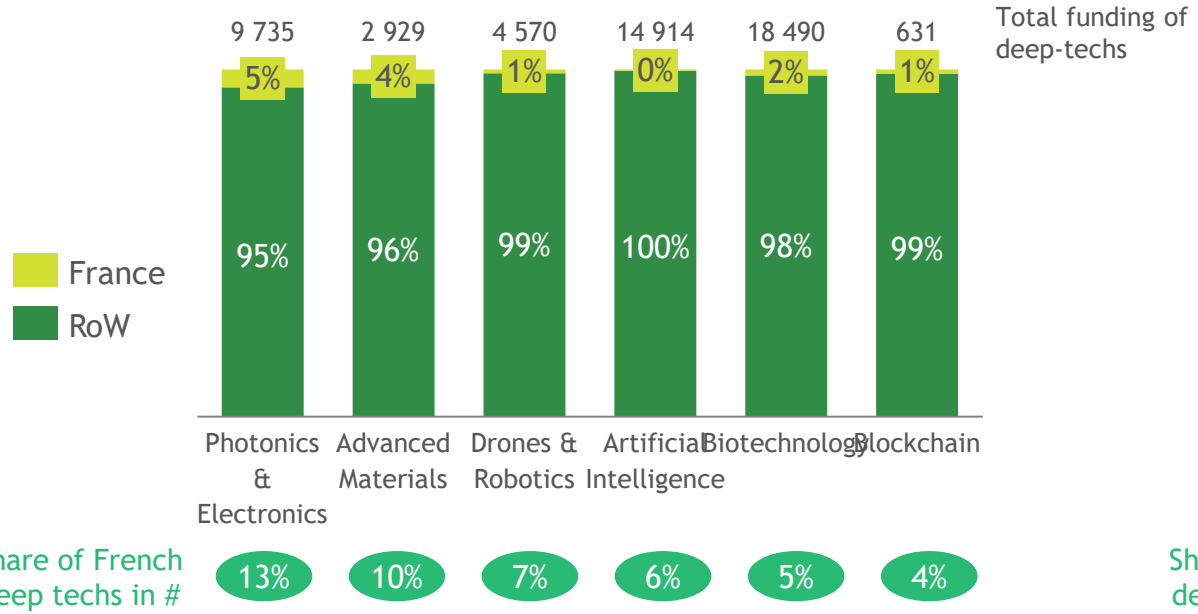


Source: BCG analysis, Quid DB, deep techs accounted when founded since 2008, Hello Tomorrow database

Although French Funding Lags, Advanced Materials and Photonics & Electronics Are Well Funded at the European Level

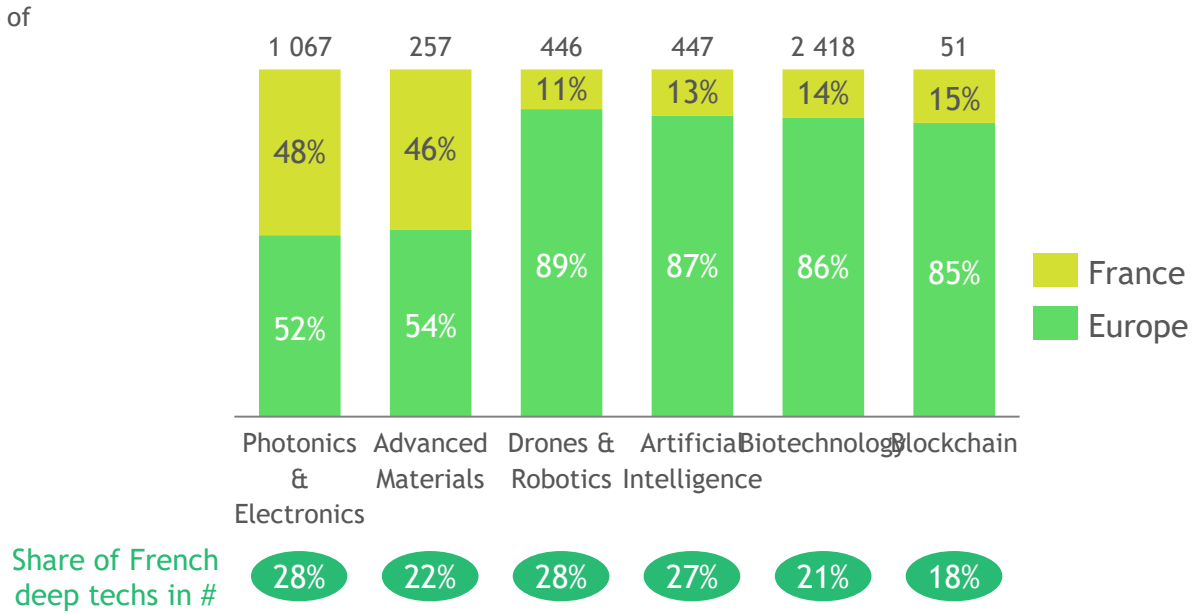
Globally, Frech funding doesn't match its presence, with lowest share in AI

% of deep techs start-ups funding per topic



At the European level, photonics and advanced materials gather ~50% of funding

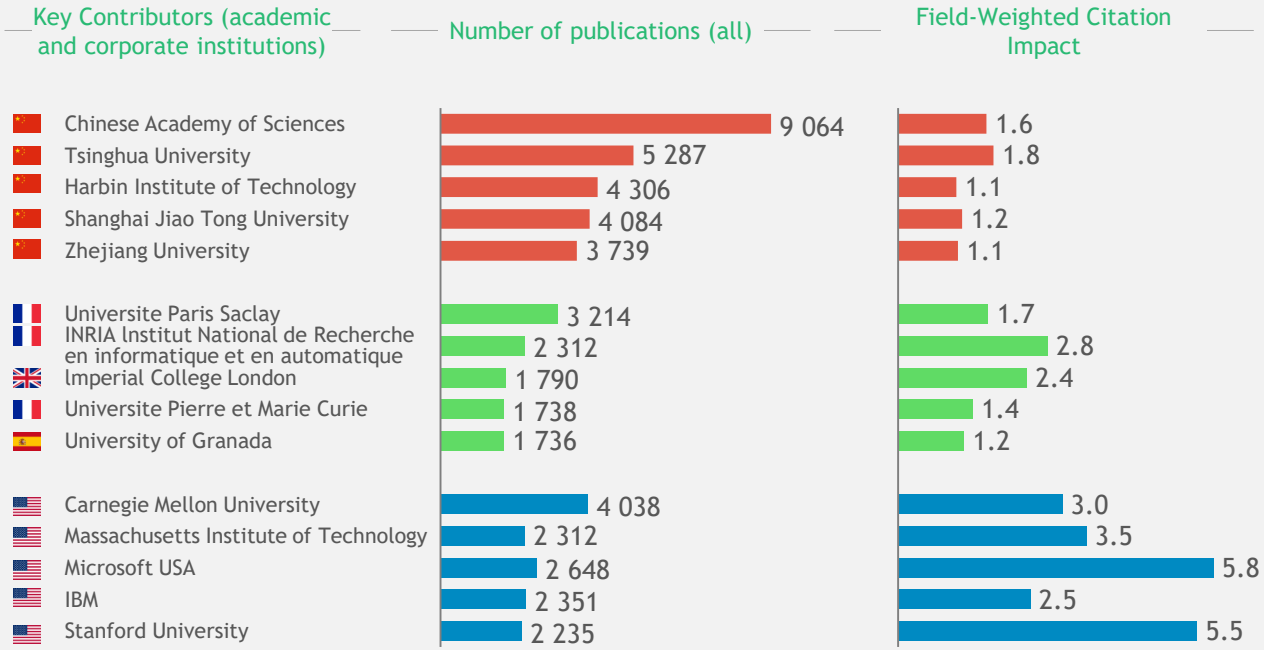
% of deep techs start-ups funding per topic



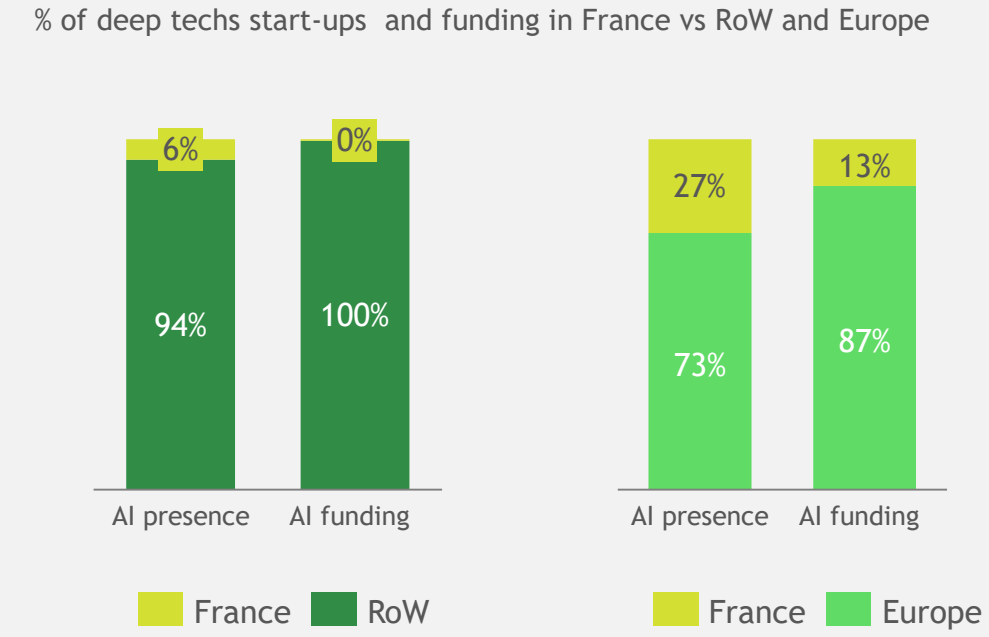
Source: BCG analysis, Quid DB, deep techs accounted when founded since 2008, Hello Tomorrow database

But France Could Increase its Presence and Funding, Benefiting from its Strong Academic Institutions, Like in AI

France has world-class academic institutions, as in AI



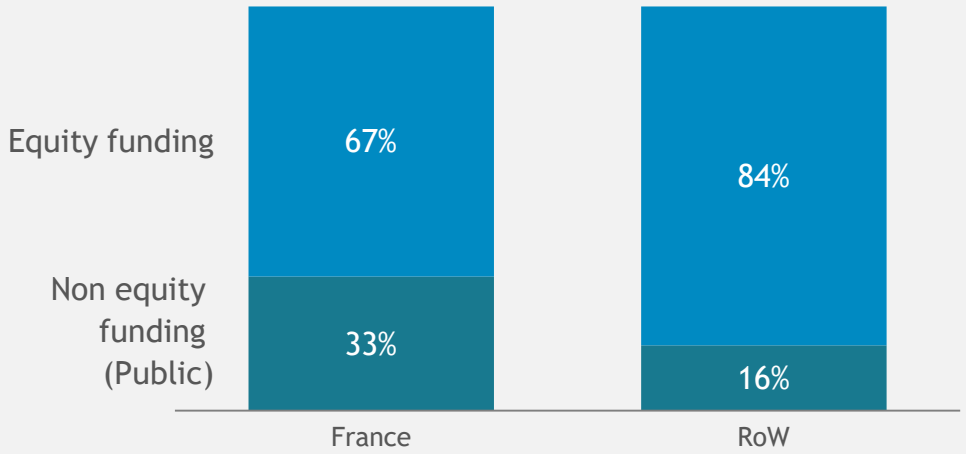
But this doesn't seem to be reflected in its deep tech blueprint



Source: Elsevier Artificial intelligence report 2018, Top 5 institutional contributors per region by number of AI publications (all document types), 2013-2017 from SciVal; BCG analysis, Quid DB, deep techs accounted when founded since 2008, Hello Tomorrow database

A Deep Dive into French Deep Tech Funding Shows that Public Financing is Much More Important than in NAM

Public funding is twice as important in France as in RoW



In France, the Banque Publique d'Investissement has launch a 2.1B€ funding program and is involved in the latest major French funding

BPI announced 2.1B€ dedicated to deep techs:

- 800m€ for seed funding (early stage of development)
- 1.3B€ for equity funding (development stage)

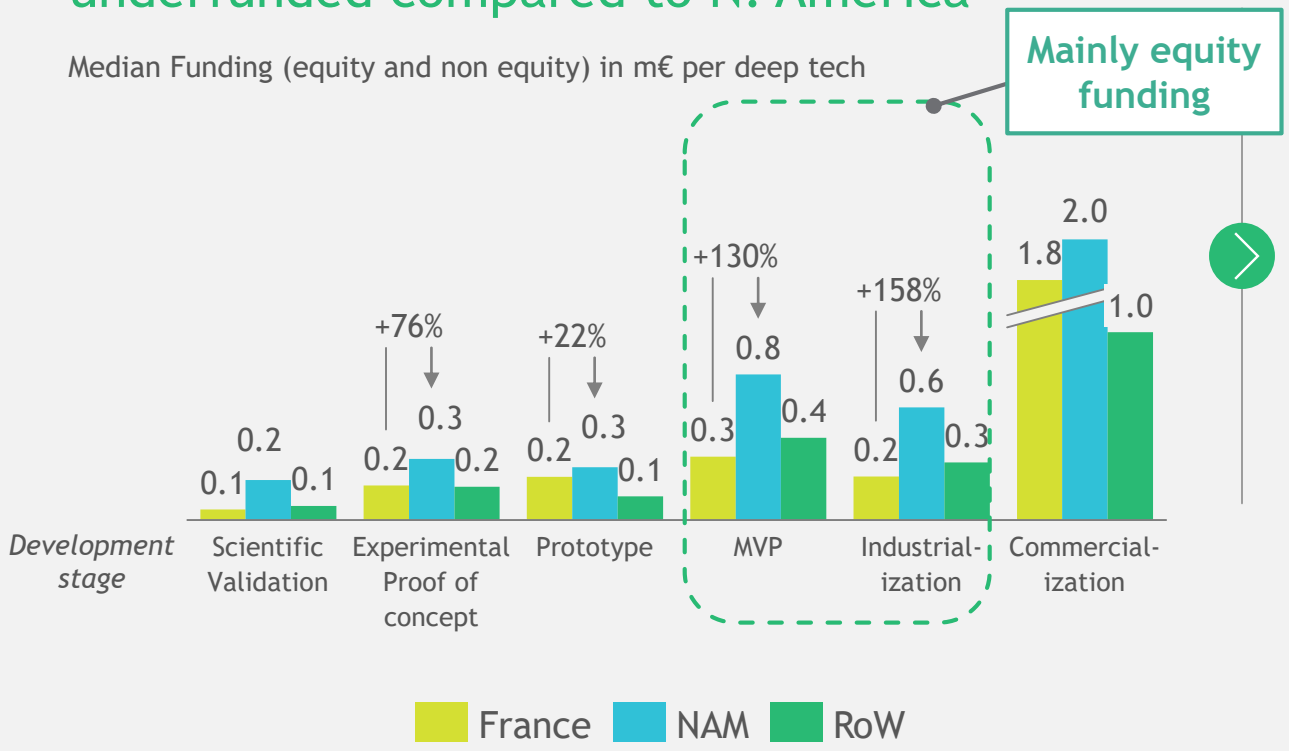
BPI is involved in the latest major deep-tech funding, such as:

- Devialet (100m€)
- Dynacure (47m€)
- Dreem (30m€)
- Wandercraft (15m€)

Source: BCG analysis, HelloTomorrow database

But France Lacks Structured VC; NAM Deep Techs Leverage Twice as Much Funding in MVP and Industrialization

Although better funded than in the rest of the world, French deep techs are largely underfunded compared to N. America



Source: BCG analysis, HelloTomorrow database

Potential for greater funding in N. America pushes some French deep techs to raise funds there

During the middle stages of development, deep techs go through MVP and industrialization and require major equity funding

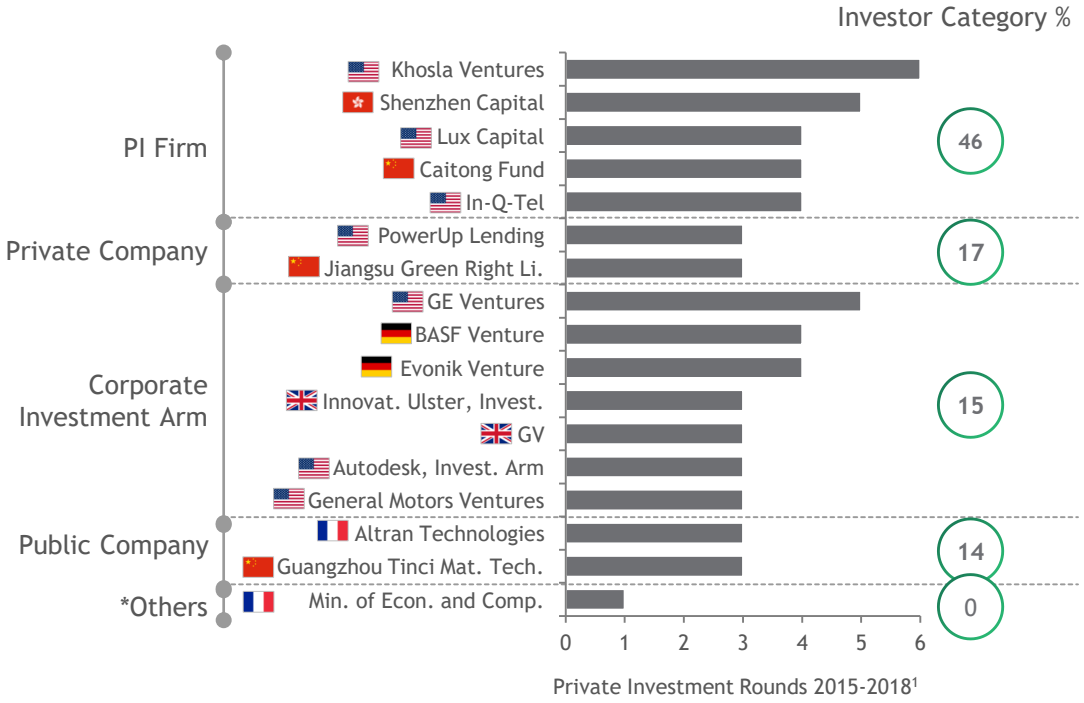
In the US, VC funds are structured to address deep techs by providing large funding on a longer time frame

Some French deep techs went to the US for financing to accelerate their development:

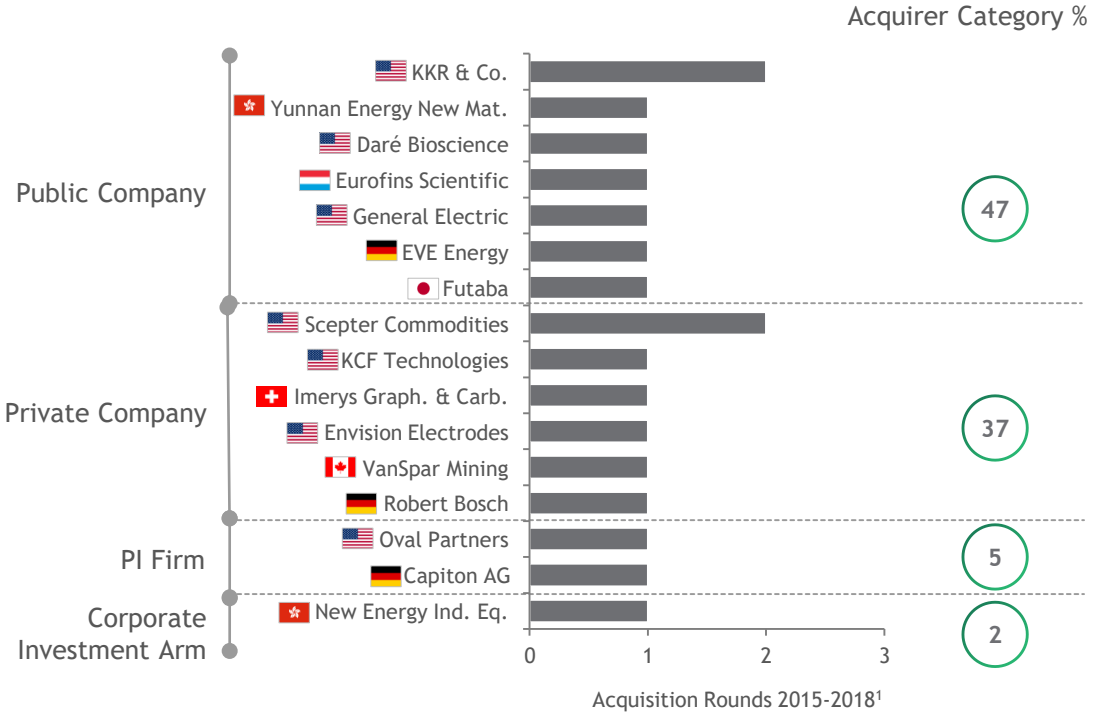
- Cellectis ($164m)
- Dataiku ($101m)
- Shift Technology ($28m)

In Advanced Materials, No French PI Funds or Corporate VCs Are Present Among the Top Investors or Acquirers

Top investors by category in advanced materials deep tech companies



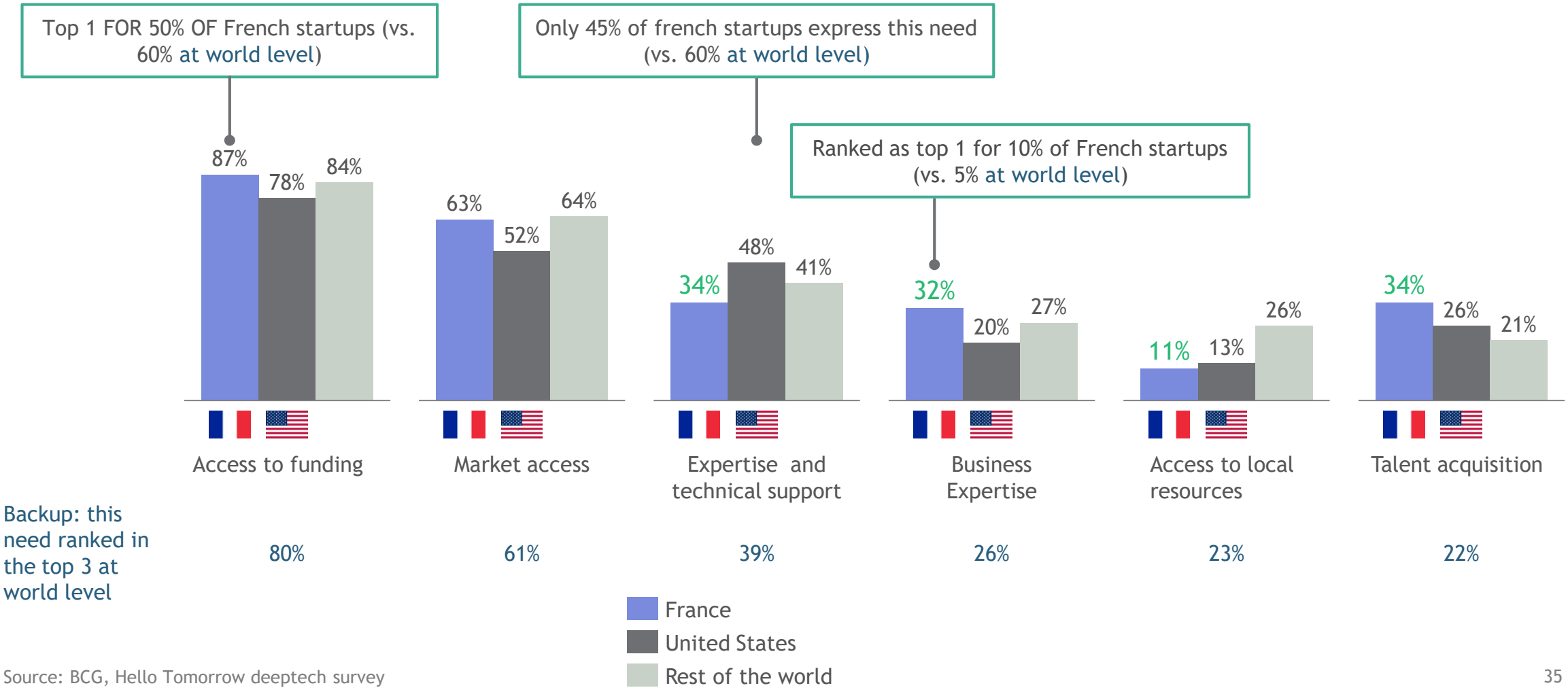
Top acquirers by category in advanced materials deep tech companies



Note: Analysis based on 987 deep tech companies related to advanced materials. *Others include public investment arm, government institutions, foundation/charitable institution, educational institution, trade association, public funds. Investor category by % shows the percentage of investments by investor type.
Source: BCG Center for Innovation Analytics

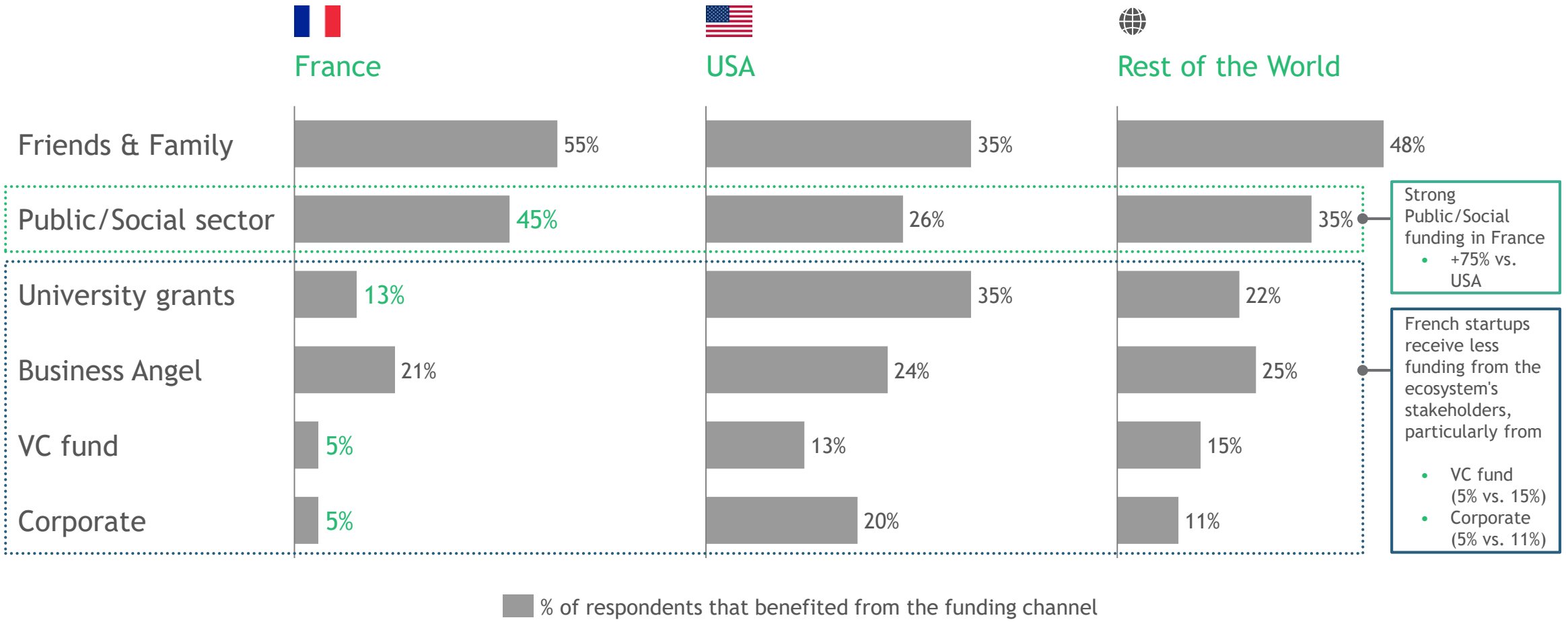
In France, Deep Techs Have Less Need for Technical Expertise and Local Resources but More Need for Business Expertise and Talent

Startups' top 3 needs/priorities



Source: BCG, Hello Tomorrow deeptech survey

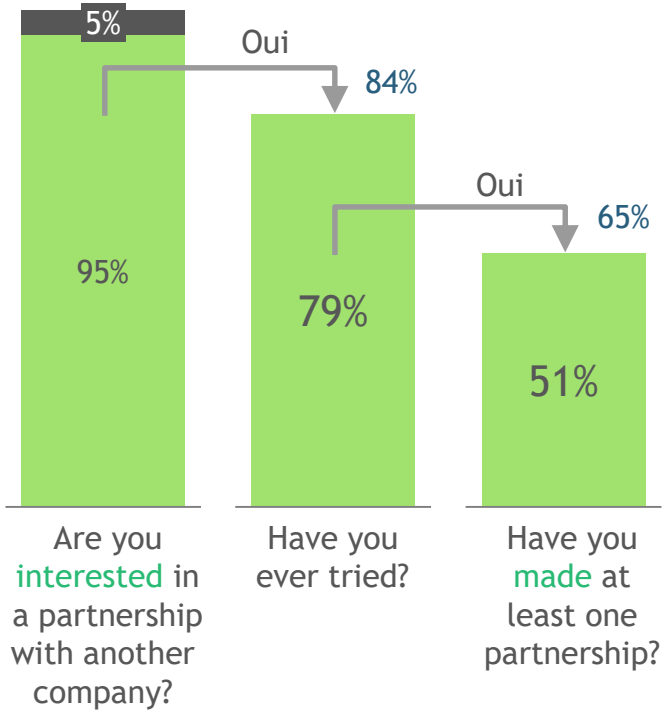
French Startups Receive Less Financial Support from Their Ecosystem (Except Public Funding)



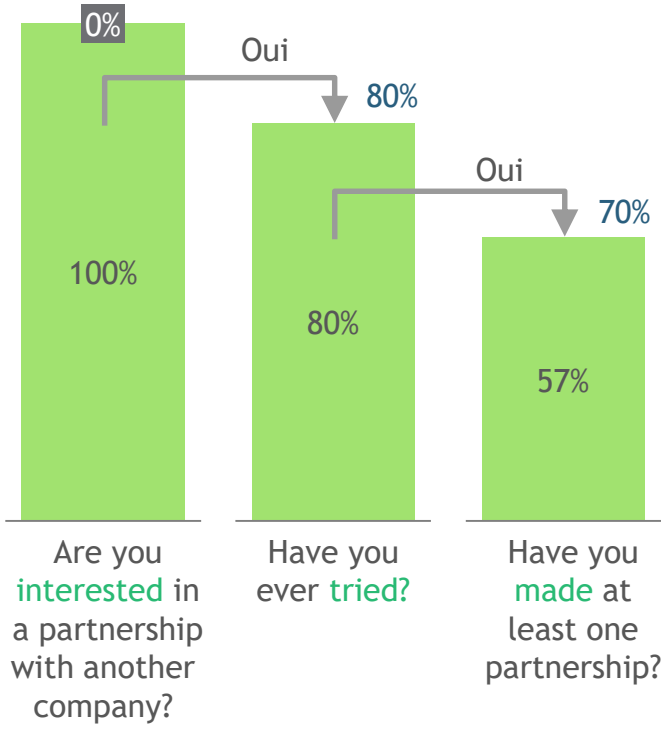
Source: BCG, Hello Tomorrow deeptech survey

In France, Startups Have Formed Fewer Partnerships with Other Companies

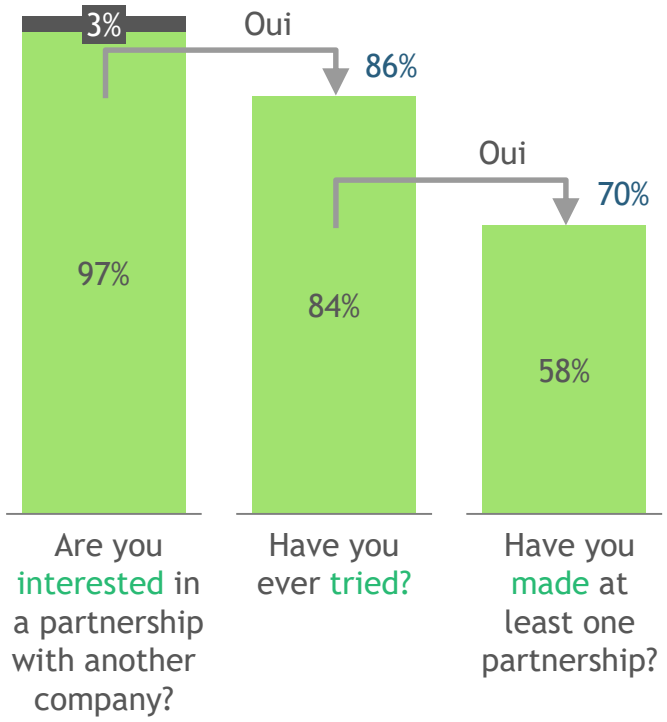
France



USA



Rest of the World



Yes NO xx % interested/ tried and tried/made Ratio

Source: BCG, Hello Tomorrow deeptech survey

Focus on Two Success Stories, Devialet and Cellectis

Devialet is a sound device company with a 100+M€ turnover

2007 – Devialet is founded based on an in-house amplifier prototype

2010 – First commercialization of its amplifier

2012 – 15M€ fund raising

2015 – Launch its famous "Phantom product"

2016 – 100M€ fund raising

2018 – Devialet technology included in the last Freebox

Cellectis was founded in 1999 over a technology transfer from Pasteur

1999 – Cellectis is founded

2003 – Conception of the meganucleases in genome engineering

2007 – Raised 21.7M€ on Euronext stock exchange

2014 – Pfizer purchases 10% of capital

2018 – Raised $164M on the Nasdaq stock exchange

APPENDIX

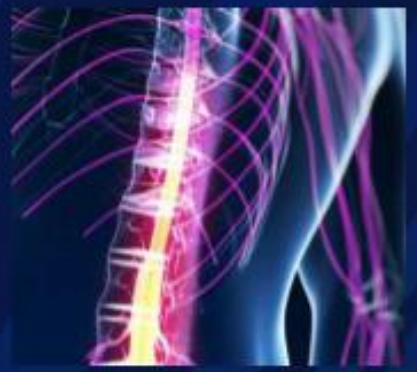
DISCOVERING DIAMONDS IN THE ROUGH

4

Hello Tomorrow Challenge winners

AND 21 BRILLIANT FINALISTS FROM OUR PREVIOUS EDITIONS WHO HAVE ALREADY RAISED OVER

$240M



GTX Medical

2014 - Switzerland

GTX Medical develops implants for the spinal chord which enable paraplegic people to walk again.

Met their CEO at the Summit, who raised $36m for GTX two years after the event.

MIT Tech Review 10 Breakthrough Technologies 2017

Biocarbon Engineering

2015 - United Kingdom

Biocarbon Engineering uses drones to plant billions of trees for mass reforestation.

Met the CEO of Parrot at the Summit who is today their most important industrial partner.

Featured at the 2017 World Economic Forum

Lilium Aviation

2016 - Germany

Lilium Aviation is on track to make their electric flying taxi a reality by 2025.

Winning the Challenge helped them gain worldwide credibility.

Raised $10m after the event, and $90m two years later.

Saathi

2017 - India

Saathi makes biodegradable sanitary pads from banana fibre, aiming to help billions of women across the globe.

Gained global exposure, attracting potential industrial partners.

Named in Forbes 30 under 30 Asia in Healthcare.