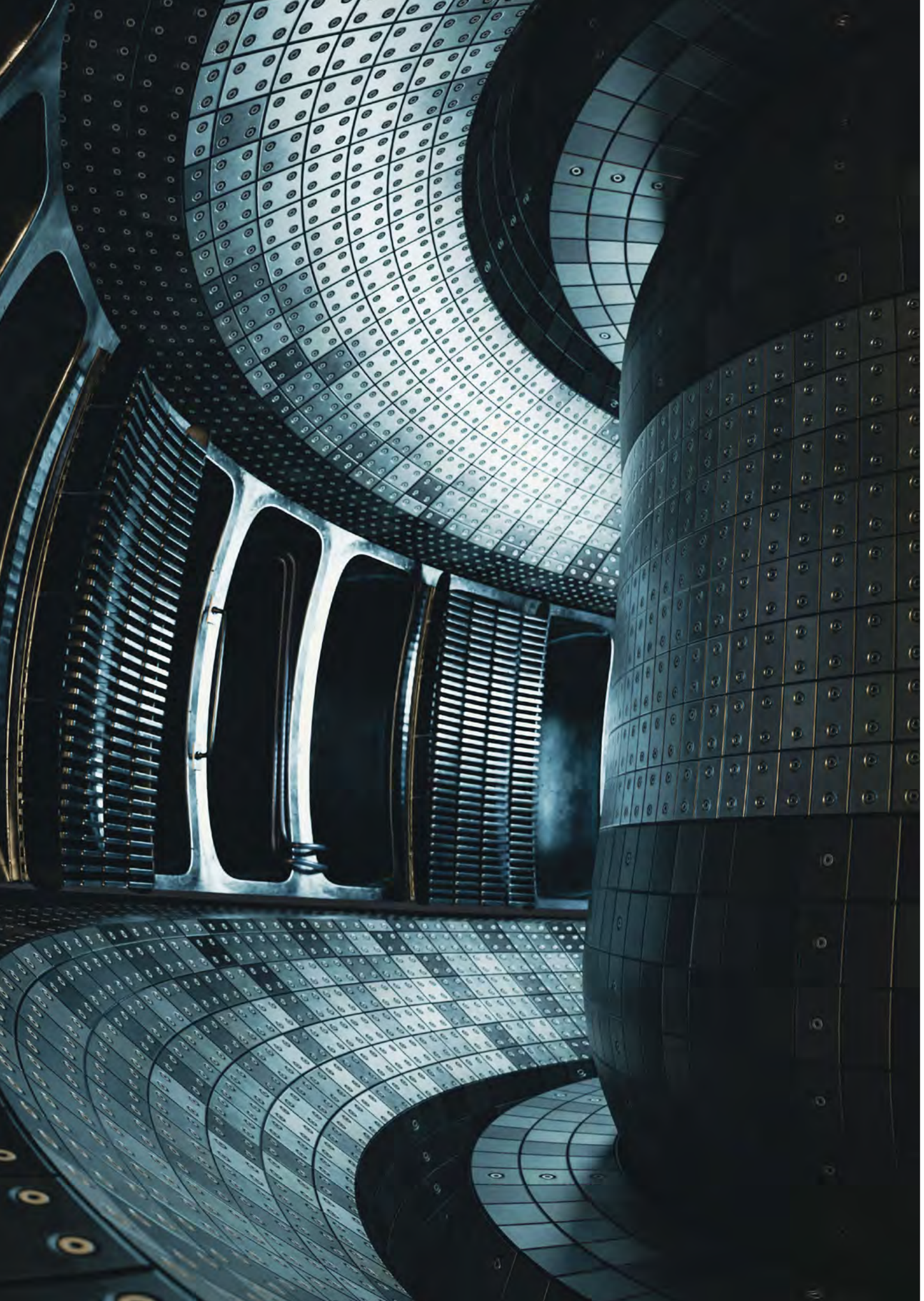
FUSION
INDUSTRY ASSOCIATION

The global fusion industry in 2023

Fusion Companies Survey by the Fusion Industry Association



FOREWORD

In December of 2022, for the first time ever on earth, a controlled fusion reaction released more energy than went into it. When the National Ignition Facility at Lawrence Livermore National Laboratory in California fired its lasers, providing about two megajoules of energy onto a tiny target, it released over three megajoules in response. With this "Wright brothers' moment," scientists showed that fusion energy production was possible.

In this third annual report on the state of the global fusion energy industry, the FIA will show how investors – and increasingly governments – are betting that the timescale to commercial fusion energy is accelerating. That is good news – the faster we can bring fusion to market, the greater its impact for business, energy security, the climate, and even global geopolitics.

Fusion Companies Aiming for Fusion in the Next Decade – or Sooner

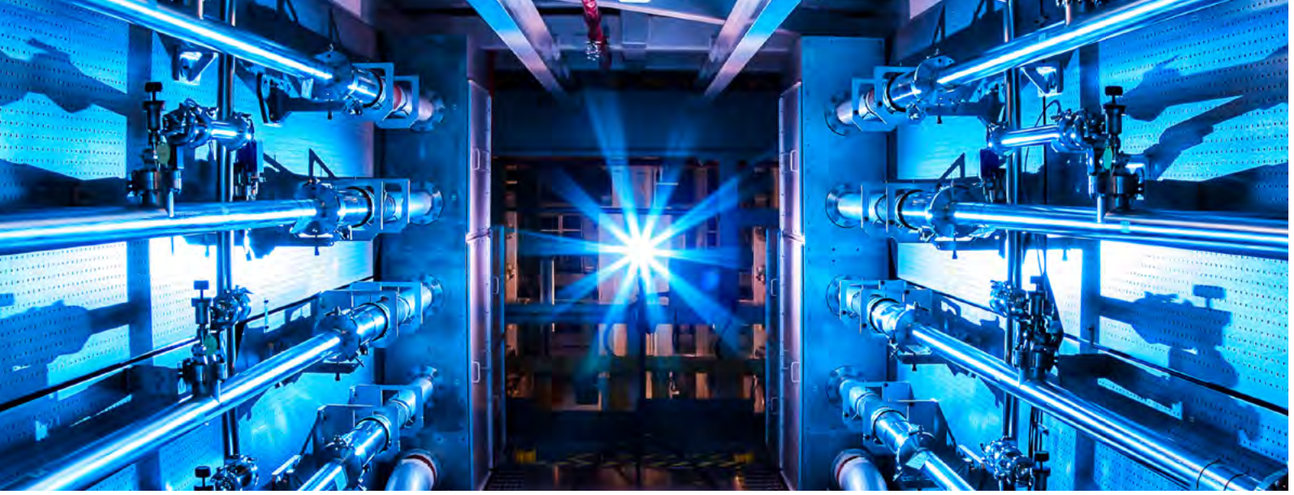
In this report, 25 companies think the first fusion plant will deliver electricity to the grid before 2035. This is up from 18 last year, partly due to a higher survey response rate. Companies are increasingly confident of meeting their ambitious goals. That will require focus on mid-term milestones, embracing risk and parallel pathways, new partnerships, and (crucially) more resources. But even as we write, multiple companies are building "proof of concept" machines that will prove fusion as a viable energy source. A fusion industry will be important whenever it comes, but the sooner it happens, the sooner it can address the world's energy challenges.

Broad-Based Increases in Investment

The headline number for this report is that the fusion industry has now attracted over $6 billion in investment, $1.4 billion more than we reported last year, and the report shows 27 companies increase their funding levels this year. Although this is less growth than last year's report, total fusion investment grew by 27% in a period where fears of inflation, interest rate increases, and even bank failures led technology investors to hold onto their money.

However, unlike the 2022 report, where a few blockbuster announcements added up to $2.8 billion in new funding, the new funding in this report primarily went in smaller amounts to early-stage companies. We are only able to document two increases of over $100 million – TAE Technologies in California and ENN in China. There were also press reports about a significant capital raise in China, larger than any other announced this year, but we could not verify details, so it is not included in this report.

Although the continued growth is notable, the lack of blockbuster investments matches anecdotal evidence heard across industry: the investment environment is challenging. And because fusion is a capital-intensive endeavour, companies will need to scale-up investment to build their proof-of-concept machines. In the last two years, traditional Venture Capital investors have grown comfortable investing in fusion, but the amount of investment they can make might be limited to the "Seed" or "Series A" investments that characterized many of the rounds announced in this report. To support the continued growth of the industry, companies will have to find a way to bridge a possible "valley of death" by bringing new investors with different pools of capital. Fusion remains an excellent opportunity for investors with access to capital.



The number of fusion companies around the world continues to grow, in what can only be described as a technology explosion. The total number of fusion companies increased to 43, up from 33 in last year's report. This report saw 13 new companies added, though three from last year are no longer in business (though some of their technologies and skills have moved to other companies).

These 43 companies are extremely technologically diverse across the "family tree" of fusion – there are very few examples of companies competing in the same technology. That diversity is a means of managing risk - 43 "shots on goal" around the world increases the chances of commercially viable fusion.

Governments Become Involved

Perhaps even more important than the volume of money going into fusion is that the last year has seen policies, procedures, and public interest that will allow fusion to rapidly grow and mature. This year, for the first time, we are seeing significant new public-private partnership programs in key nations. Eighteen companies reported they were involved (or would soon be) in a public-private partnership with government.

Around the world, these programs are diverse in their aims and funding levels, but there is a clear trend towards government interest in fusion. The United States, Japan, and Germany made announcements in early 2023 about new programs to support fusion commercialization, in addition to the already robust support in the United Kingdom.

In the number of private fusion companies, the US remains dominant, with 25 companies and the bulk of investment, but we have also seen important growth in countries like Japan, China, Australia, New Zealand, Germany, and Israel, while the UK and Canada have serious advanced contenders. As fusion grows, perhaps these public-private partnerships can help to bridge the "valley of death" if private markets cannot.

Likewise, a regulatory framework for fusion – separate from nuclear fission regulation – is moving forward as well, with the United Kingdom being the first-mover, followed by a decision by the U.S. Nuclear Regulatory Commission in April 2023. This regulatory certainty will de-risk fusion and could unlock further private investment.

Finally, fusion companies agree that challenges remain. Fusion is hard. A large majority large majority of firms say there are still many technical science and engineering challenges around achieving fusion power efficiency, resolving plasma science, and heat management. And almost every company still thinks funding is a challenge, as plenty more will still be needed to get to commercial viability.

No journey worth taking was ever easy. But for all the challenges, it remains an exciting and promising time to be in the fusion industry – thanks for reading our report, and we hope you can join us at www.fusionindustryassociation.org!

About the Report

This is the third annual "Global Fusion Industry Report" from the Fusion Industry Association. In this report, we strive to be impartial, presenting the information on the various companies as it has been conveyed to us. All company achievements and data are entirely self-reported. It is not an exhaustive survey. We approached the fusion businesses that we know about and where contact information was available. Their responses were voluntary.

In this third report, we're more confident that we've reached the global fusion industry. Of course, there may be small "stealth" companies that are not ready for publicity, but we believe this year's report now represents all the major players. The one possible exception is a Chinese company that the press reported significant investments in, but where we could not track down contact information.

Beyond that, this survey should be seen as a snapshot in time; a view of the industry when the survey was conducted in the second quarter of 2023. Repeating the activity year-on-year enables us to see the picture evolving.

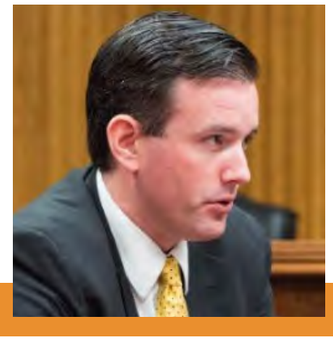
Many private fusion companies are members of the Fusion Industry Association, though this is not a requirement for the report, and we strive to treat members and non-members the same.

Membership is marked on company pages by an FIA Member badge. Membership of the FIA is simple: it requires companies to have a plan for fusion commercialization, to demonstrate private investment to support their mission, and to pay dues. Companies playing a supportive role in the fusion industry may join as Affiliate Members, but these wider-industry companies are not the subject of this report. Our Supply Chain Report, released in May 2023, reflects the status and views of these companies.

About The Fusion Industry Association (FIA)

The FIA is the unified voice of the new fusion industry and a central point for coordination across the fusion community to support accelerated growth. The FIA is a registered non-profit organization, headquartered in Washington, DC, composed of private companies working to commercialize fusion power. The Association advocates for policies that would accelerate the race to fusion energy. Details about membership are available at: https://www.fusionindustryassociation.org/membership/.

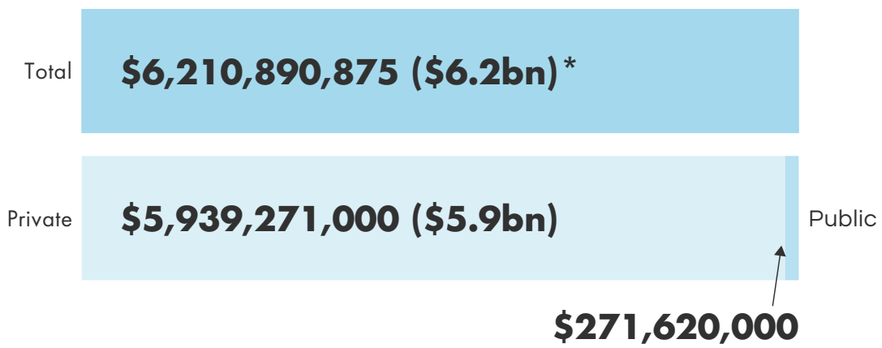
The FIA would like to give special thanks to Memetic Communications for their work in pulling together the data and publishing the report.



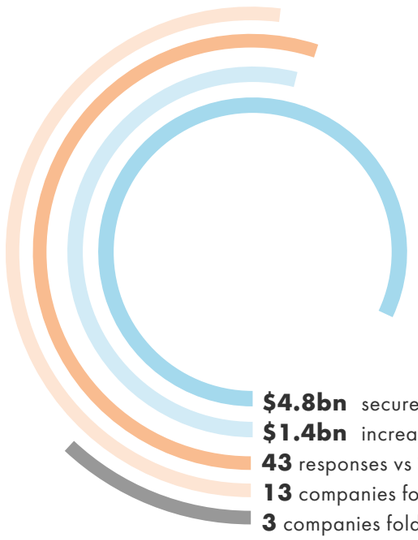
Andrew Holland
Chief Executive Officer
Fusion Industry Association

HIGHLIGHTS TO DATE

1. Funding for fusion companies



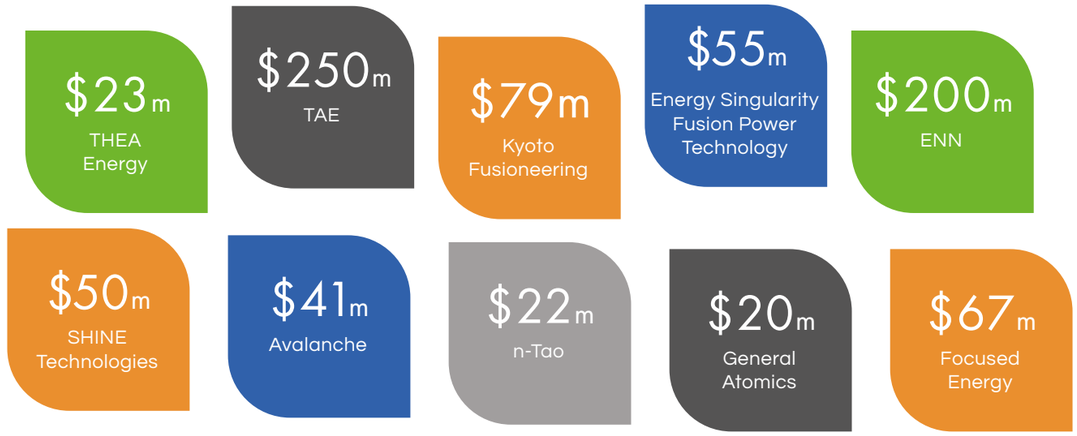
2. Change since 2022 survey



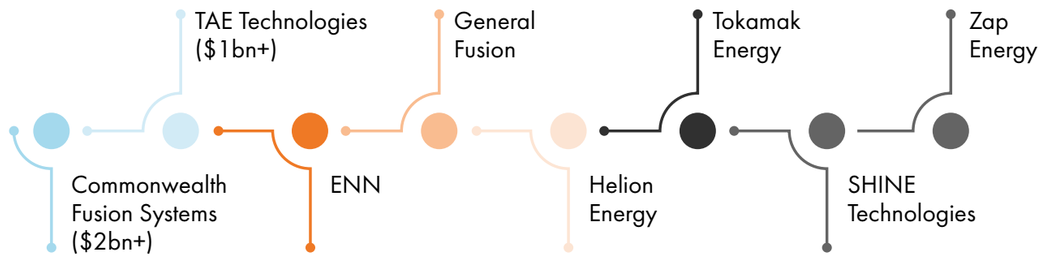
$4.8bn secured at time of 2022 survey
$1.4bn increase in total funding since 2022 (including some funding not previously declared)
43 responses vs 33 in 2022 and 23 in 2021
13 companies founded or emerged from stealth mode
3 companies folded/joined others

* Some figures have been rounded. Some funding was declared privately, hence total figure here is higher than combined figures stated in company profiles.

3. Notable investments since the last survey



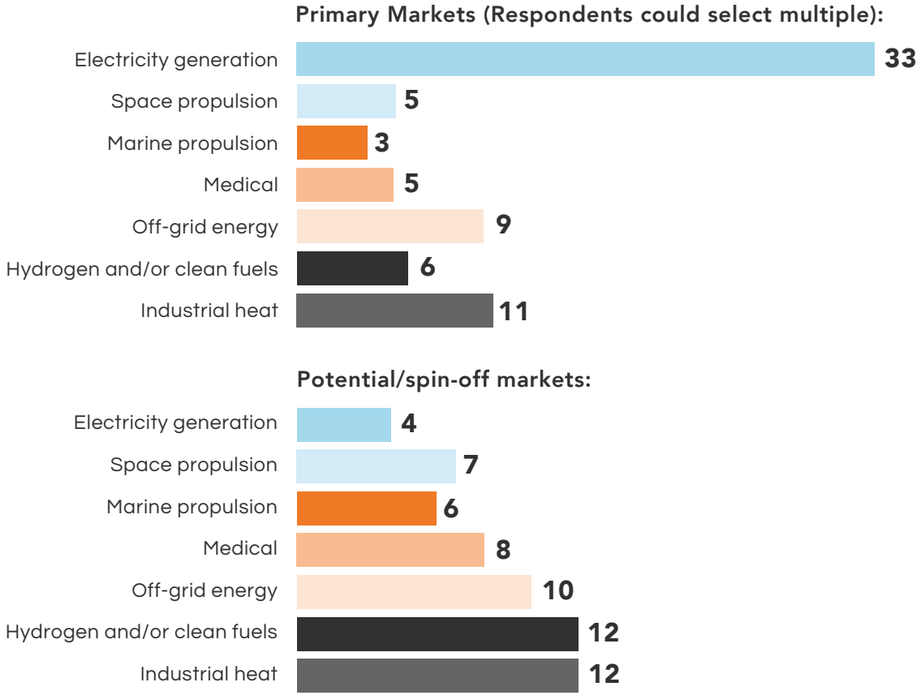
4. Companies with $200m investment or more



5. Location

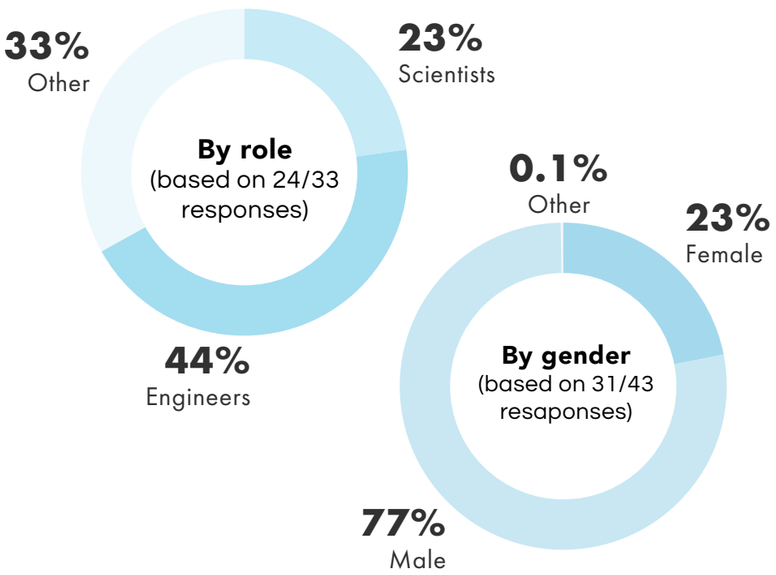
By primary HQ

6. Target markets



7. Employees

Numbers are approximate and based on companies estimated figures, rounded to nearest 10%. Companies that did not provide demographic and role data are not reflected in these figures.



8. Industry growth

975
new jobs
created (based on 33 responses)

~3,000
estimated jobs created in the supply chain
(based on 20 responses)

9. Selected* investors in fusion

Addition
Alcen
Art Samberg
Bezos Expeditions
Bill Gates
Blackbird Ventures
Braavos Capital
Braemar Energy Ventures
Breakthrough Energy Ventures
Bruker
Business Development Bank of Canada
Capricorn Investment Group
Cenovus Energy
Charles Schwab
Chevron Technology Ventures
Chrysalix Venture Capital
Coatue
Congruent
Coral Capital
Darco Capital
David Harding
DBJ Capital Co., Ltd.
DCVC
DFJ Growth
Doral Energy
Dr Hans-Peter Wild
Dustin Moskovitz
EIT InnoEnergy
Electric Power Development Company
Emerson Collective
Energy Impact Partners
Eni
Enlightenment Capital
Equinor
Fine Structure Ventures
Footprint Coalition
Founders Fund
Future Ventures
GA Capital
German Federal Agency For Disruptive Innovation
GIC
Google
Grantham Foundation
Hofima
Hostplus
HTGF
Icehouse Ventures
Inpex Corporation
IP Group
J-POWER
JAFCO Group
Jameel Investment Management Company (JIMCO)
Jeff Bezos
JGC MIRAI Innovation Fund
JIC Venture Growth Investments
John Doerr
JS Capital
K1W1 Ventures
K4 Ventures
Kam Ghaffarian
KDDI
Khazanah Nasional
Khosla Ventures
KTH Holding
Kuwait Investment Authority
Lowercarbon Capital
miHoYo
MILFAM
Mitsubishi UFJ Capital
Mitsui Kinzoku
MOL PLUS
MSIVC
New Zealand Growth Capital
Ngāi Tahu
Nikon
Nissay Capital
Orbia Ventures
Outset Ventures
Plural Platform
Prelude Ventures
Radar Ventures
SBI Investment
SDGx
Segra Capital Management
SET Ventures
Shorewind Capital
SMBC Capital
Sony
Starlight Ventures
StartEngine
Sumitomo
TDK Ventures
Temasek
Toyota
Trirec
UVC Partners
Vahoca
Venture Growth Investments Co., Ltd.
Wilbe
Wireframe Ventures
Wisconsin Alumni Research Foundation (WARF)
YUNHE Partners

*All of these investors have been publicly identified in previous publications. The FIA is not responsible for the responses listed in this report from survey participants and do not intend to disclose any proprietary information.

10. Public Private Partnerships

15
companies engaged in Public Private Partnerships

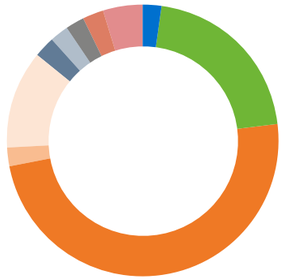
3
plan to be soon

$70,000,000
value in government funding if milestones met*

NOTABLE PPPS
INFUSE, ALCF, ERCAP, Defence Innovation Unit, Canada's Strategic Innovation Fund

*based on nine respondents who reported their share

11. Approach



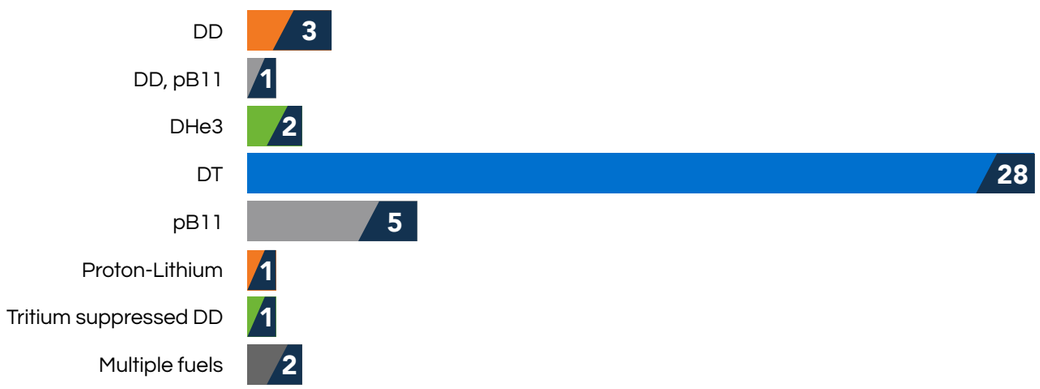
General approach

- **1** Electrostatic Hybrid
- **9** Inertial confinement
- **21** Magnetic confinement
- **1** Hybrid magnetic and electrostatic confinement
- **5** Magneto-intertial
- **1** Muon-catalyzed fusion
- **1** Non-thermal laser fusion
- **1** Closed Orbit, velocity resonant systems
- **1** Rydberg matter fuel-based fusion (non-traditional)
- **2** Non-traditional concepts/Not stated/TBC

Specific approach

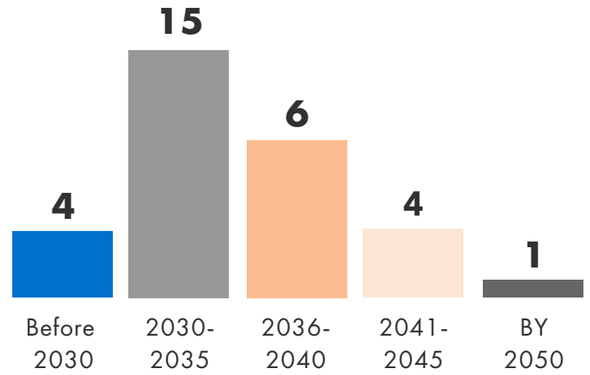
- **1** Dense Plasma Focus
- **1** Direct laser-driven pB11
- **1** Epicyclotron: a hybrid beam background approach
- **1** Electro-centripetal confinement with magnetic plasmas not in thermodynamic equilibrium
- **3** Field Reversed Configuration
- **1** Hypervelocity Gradient Field Fusion
- **1** Laser-driven inertial confinement
- **1** Laser-driven Direct Drive Inertial Confinement Fusion
- **1** Levitated Dipole
- **1** Magnetic mirror
- **1** Mirror machine
- **1** Magnetized target fusion
- **1** Modified Stellarator
- **1** Muon-catalyzed fusion with high density fuel
- **2** Magnetic-electrostatic confinement
- **1** Magnetized Liner Inertial Fusion (MagLIF)
- **1** Plectonemic reconnection
- **1** Poloidal magnetic confinement, e.g. Levitron, LDX, Intrap
- **1** Pulsed magneto-plasma pressurized confinement
- **1** Shock-driven inertial confinement
- **1** Spindle cusp, superconducting shielded-grid Inertial Electric Confinement
- **6** Stellarator
- **6** Tokamak/Spherical Tokamak/Advanced Tokamak
- **2** Z-pinch
- **1** N/A

12. Fuel Source

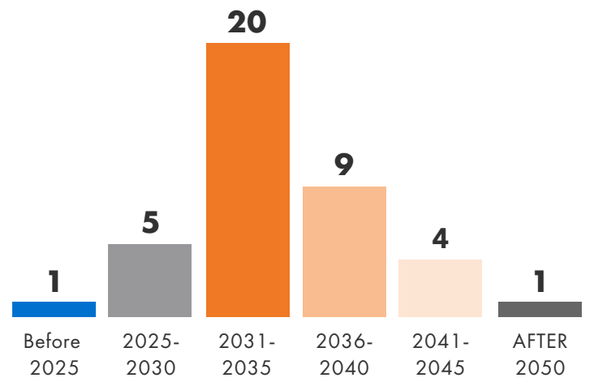


13. Predictions/challenges

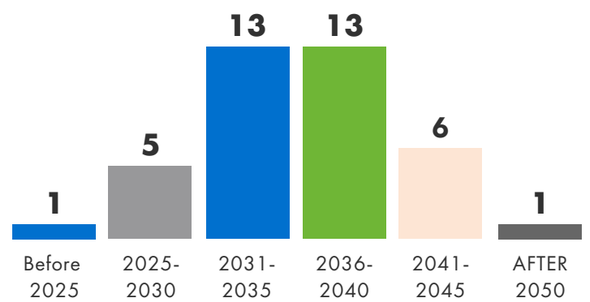
When do you anticipate your company will deliver power to the grid (30 responses)



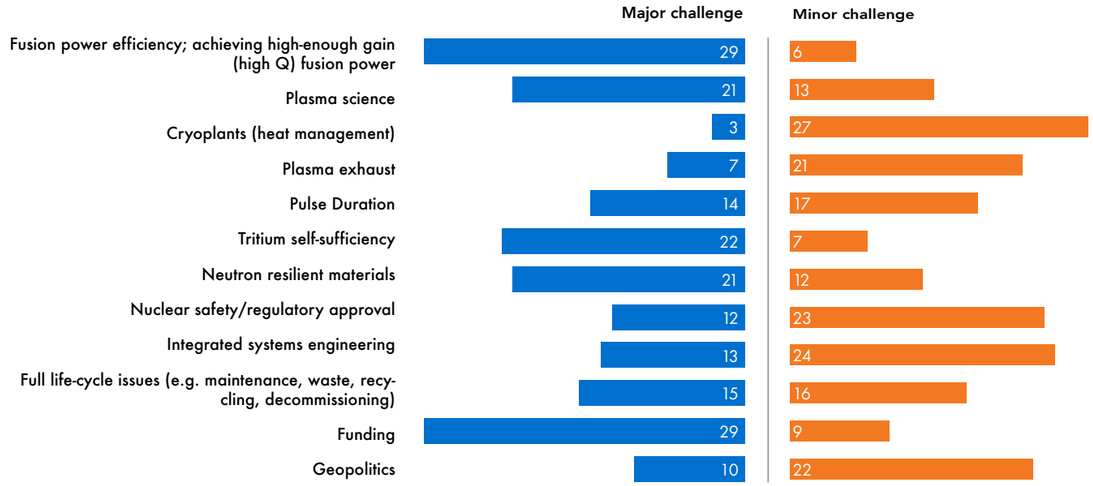
When will the first fusion plant deliver electricity to the grid? (40 responses)



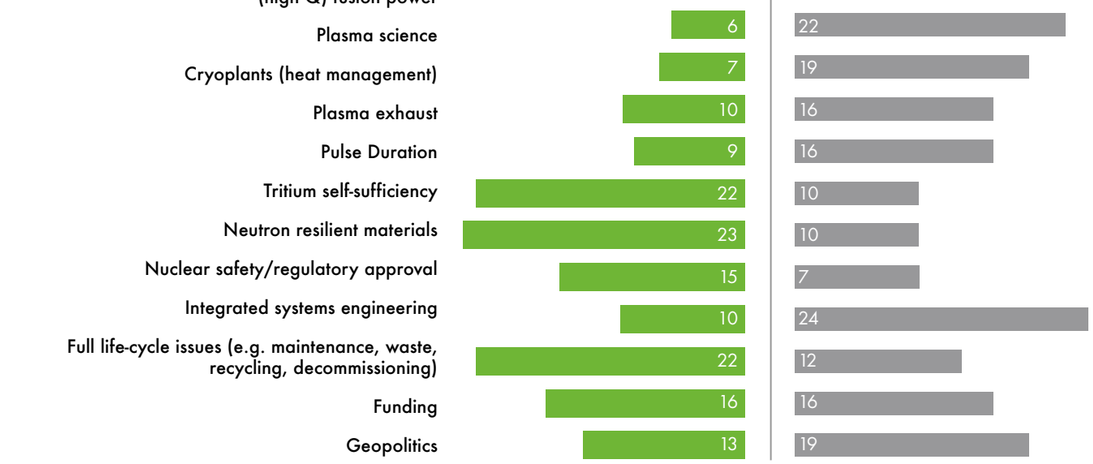
When will the first fusion plant demonstrate a low enough cost/high enough efficiency (Q) to be considered commercially viable? (40 responses)



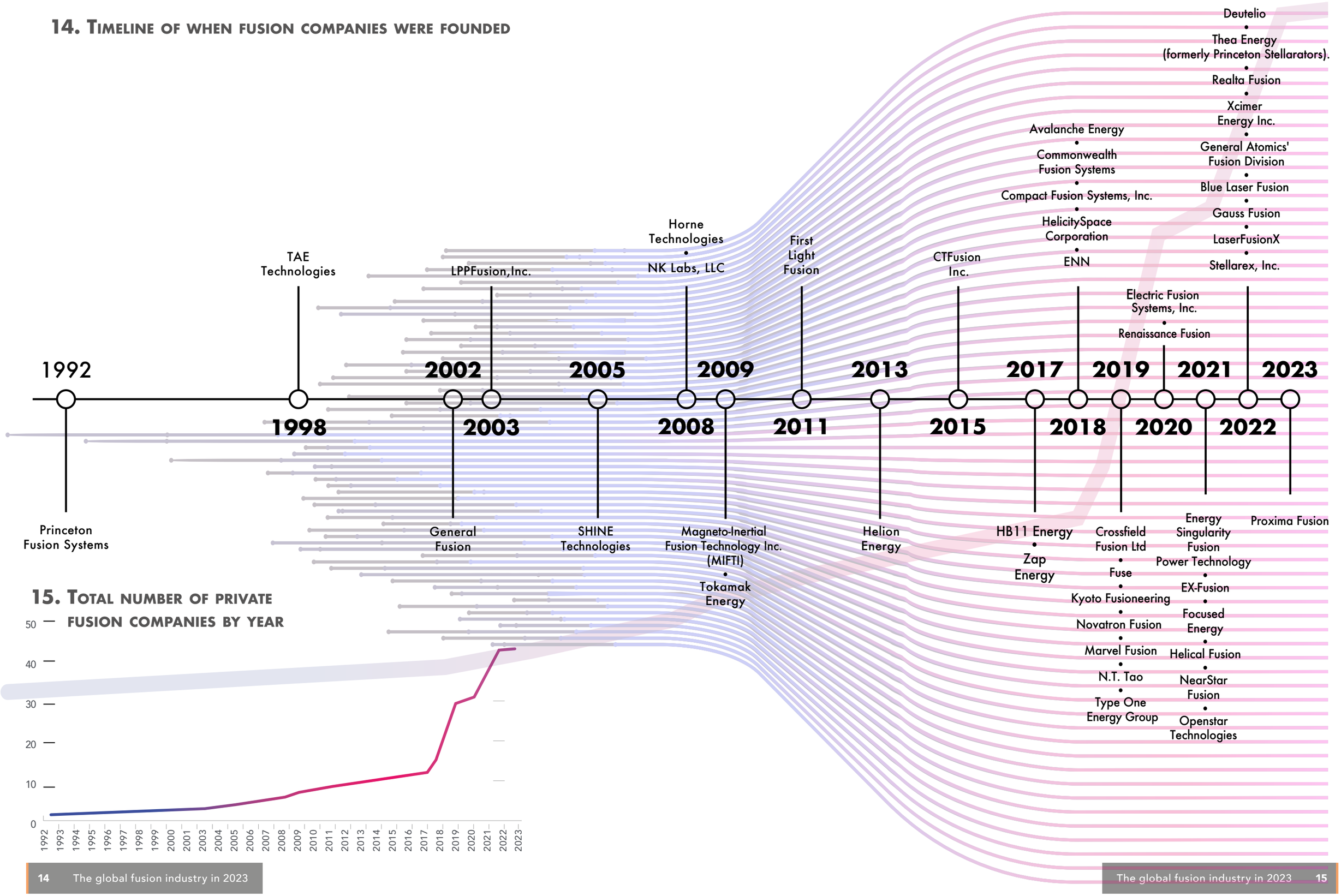
What do you see are the main challenges for fusion energy up to 2030? (38 Reponses, non-reported answers indicate not seen as a problem/don't know)



What do you see are the main challenges for fusion energy after 2030? (38 Reponses, non-reported answers indicate not seen as a problem/don't know)

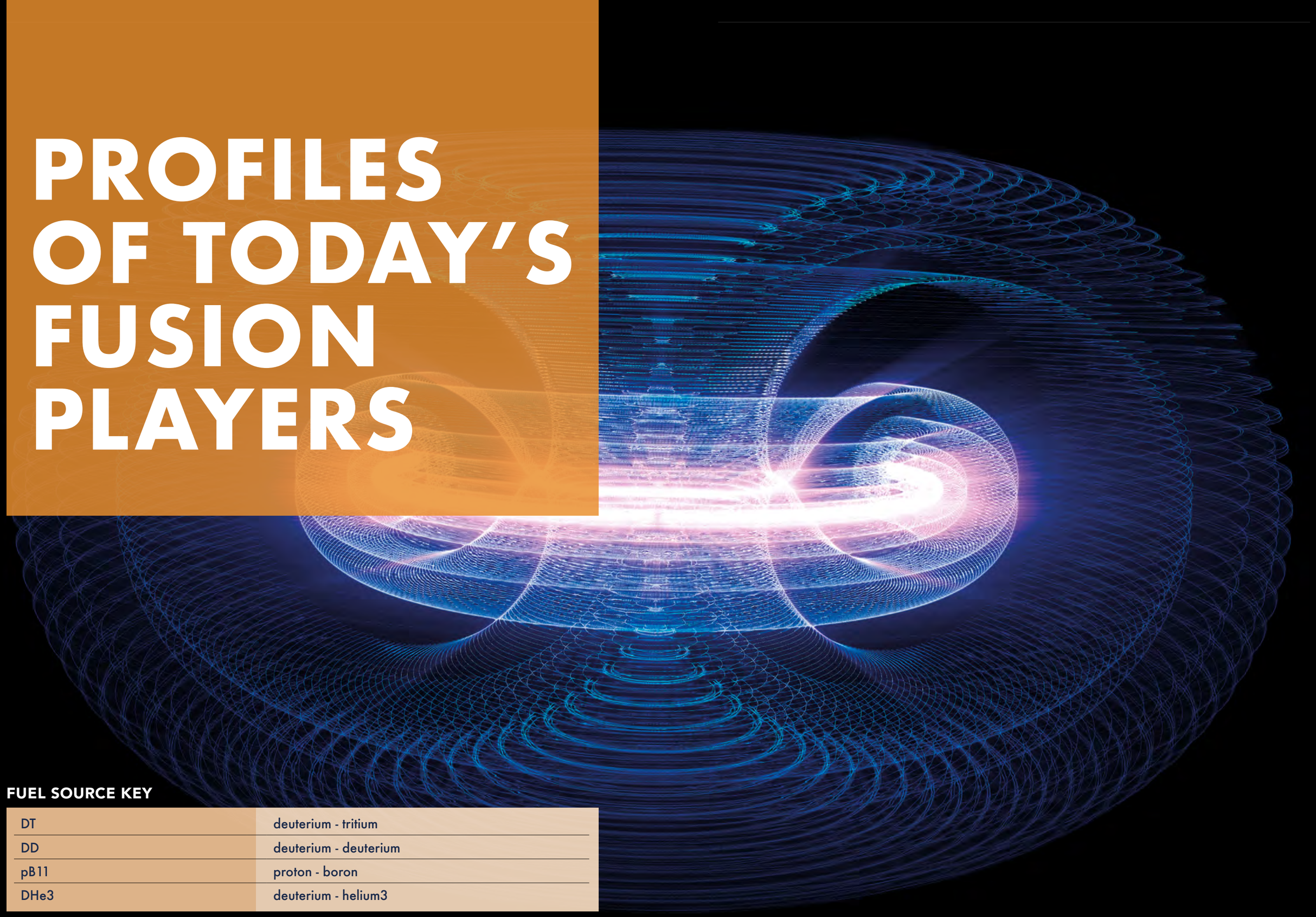


14. Timeline of when fusion companies were founded



15. Total number of private fusion companies by year

PROFILES OF TODAY'S FUSION PLAYERS



FUEL SOURCE KEY

DT	deuterium - tritium
DD	deuterium - deuterium
pB11	proton - boron
DHe3	deuterium - helium3

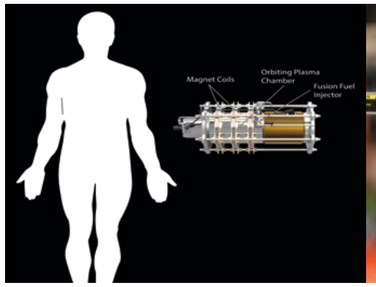
FIA MEMBER

AVALANCHE

AVALANCHE ENERGY

Avalanche Energy is developing a modular 5kWe fusion microreactor, called the Orbitron, for hard-to-decarbonize applications. Its compact size and modularity are game changers for dual-use, mobile and distributed power applications across air, land, sea, and space. Some potential applications include islanded micro-grids in austere/remote environments, electric vehicle battery recharging, and spacecraft power and propulsion.

Location	Tukwila, Washington, USA
Contact Details	reachout@avalanche.energy
Year founded	2018
Founder Names	Robin Langtry, Brian Riordan
Primary target markets	Space propulsion, Marine propulsion, Mobility
Total declared funding to date	$53,000,000
Employees (incl. full time consultants)	27
General approach	Hybrid electrostatic confinement
Specific approach	Magnetic-electrostatic confinement
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	Q4/2025 delivery of first prototype to DIU/DoD for qualification testing. Orbital demonstration in 2028.
Anticipated MWe of your commercial operating facility?	0.005 MWe per module
Milestones in past 12 months	Reached an operating voltage of 200 kV (kilovolts) with second generation fusion device "Marty", surpassing previous record of 190 kV set by University of Wisconsin at Madison.
Key collaborators/partners	Defense Innovation Unit (DIU)
Recent spin outs/patents/commercial innovations	US Patent: US11568999B2 Orbital Confinement Fusion Device
Recent published papers	A Compact, 300-kVDC Bushing for Operation under Ultra-High Vacuum Pressure, IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP) pp. 471-474. (October 2022).



© Avalanche Energy Ltd

© Avalanche Energy Ltd

BLUE LASER FUSION

FIA MEMBER

BLUE LASER FUSION INC.

Blue Laser Fusion is developing an inertial confinement fusion device with a proprietary and novel laser source.

Location	Palo Alto, California
Contact Details	Not provided
Year founded	2022
Founder Names	Shuji Nakamura and Hiroaki Ohta
Primary target markets	Electricity generation
Total declared funding to date	$500,000
Employees (incl. full time consultants)	4
General approach	Inertial confinement
Specific approach	Laser-driven inertial confinement
Fuel Source	pB11
Planned energy capture approach	Direct energy conversion
Pilot plant timescale	2030

Commonwealth Fusion Systems

FIA MEMBER

COMMONWEALTH FUSION SYSTEMS

Commonwealth Fusion System's (CFS) mission is to deploy fusion power plants to meet increased global energy demand and decarbonization goals as fast as possible. CFS leverages decades of research in tokamaks combined with new groundbreaking high-temperature superconducting (HTS) magnet technology. CFS is currently constructing SPARC, a Q~10 demonstration plant based on peer-reviewed science, using fusion fuels.

Location	Devens, Massachusetts
Contact Details	info@cfs.energy
Year founded	2018
Founder Names	Bob Mumgaard, Dan Brunner, Brandon Sorbom, Dennis Whyte, Martin Greenwald, and Zach Hartwig
Primary target markets	Electricity generation
Total declared funding to date	> $2,000,000,000
Employees (incl. full time consultants)	>500
General approach	Magnetic confinement
Specific approach	Tokamak
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2025: SPARC demonstration fusion plant is operational Early 2030s: First fusion power plant, called ARC, is completed
Anticipated MWe of first commercial operating facility	400MWe
Interim plants or facilities planned	2025: SPARC is operational - a machine that will demonstrate commercially relevant net energy from fusion, many fusion subsystems, and the delivery of a near full scale system.
Recent company investments	-Completed construction and moved into new HQ in Devens MA in Dec 2022 -Completed construction and moved into new Magnet Factory in Devens MA in Dec 2022 -Construction ongoing for SPARC facility in Devens, MA

Key collaborators/partners	Partial list includes: Massachusetts Institute of Technology; Brookhaven National Lab; Columbia University; Idaho National Lab; Lawrence Berkeley National Lab; Lawrence Livermore National Lab; Max Planck Institute for Plasma Physics; National Renewable Energy Laboratory; Oak Ridge National Lab; Princeton Plasma Physics Lab; Robinson Research Institute; Sandia National Laboratory; Type One Energy; UKAEA; University of California at San Diego; University of Maryland; University of Rochester; University of Texas at Austin; University of Torino; University of Wisconsin; University of York.
Recent published papers	[1] FERMI: Fusion Energy Reactor Models Integrator, Fusion Science and Technology, 79:3, 345-379, DOI: 10.1080/15361055.2022.2151818. (2023) [2] Virtual prototyping of liquid metal blanket performance in fusion pilot plant, Fusion Engineering and Design, Volume 191, 2023 T. Looby et al. 3D ion gyro-orbit heat load predictions for NSTX-U. 2022 Nucl. Fusion 62 106020 [3] Commonwealth Fusion Systems path to commercialization. Bulletin of the American Physical Society. 2022 Oct 17. [4] Design concepts for visible, UV and IR imaging and spectroscopy diagnostic systems for SPARC. Bulletin of the American Physical Society. 2022 Oct 20. [5] Brunner D. Overview of the high-field path to fusion energy. Bulletin of the American Physical Society. 2022 Oct 19. [6] Sircar A, Badalassi V. MHD turbulence models for fusion reactor blankets. Bulletin of the American Physical Society. 2022 Nov 22.

CROSSFIELD FUSION LTD

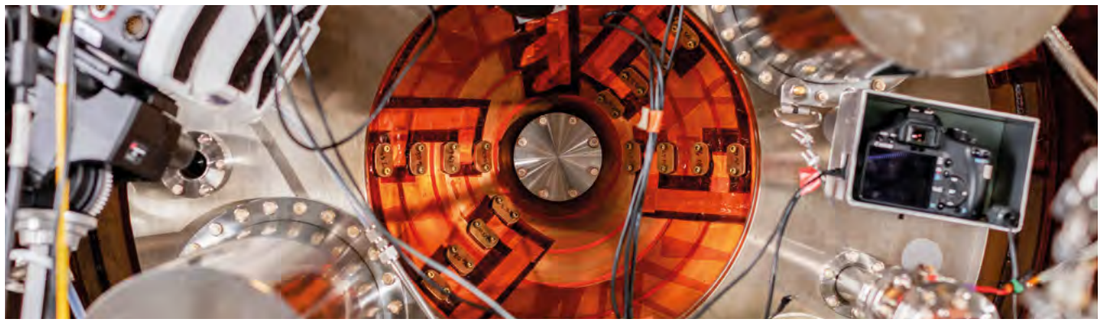
usion start-up, prototyping novel methods for accelerating and manipulating fusion fuel ions for fusion-neutron and isotope production.

Location	London, UK
Contact Details	enquires@crossfieldfusion.com
Year founded	2019
Founder Names	James McKenzie & Chris Macdonald-Bradley
Primary target markets	Medical; commercially relevant neutron source, including isotope manufacture and fusion-energy-spectrum relevant materials testing
Total declared funding to date	$500,000
General approach	Closed Orbit, velocity resonant systems
Specific approach	Electro-centripetal confinement with magnetic plasmas not in thermodynamic equilibrium
Fuel Source	DD
Anticipated MWe of your commercial operating facility?	Initial objective; ~10kW neutron flux (~Peta. neutron/s)
Interim plants or facilities planned	Commercially relevant neutron sources
Milestones in past 12 months	Operations on initial prototypes completed, IP in progress, not currently for disclosure
Key collaborators/partners	Venture and private capital
Spin outs/patents/innovations	Tritium handling

DEUTELIO

Deutelio aims to achieve nuclear fusion by magnetic confinement with the Polomac configuration, using the Deuterium-Deuterium reaction. It plans a small prototype to validate and tune the magnetic tunnels within three years, to design the first nuclear reactor in five years and achieve some electricity in ten years.

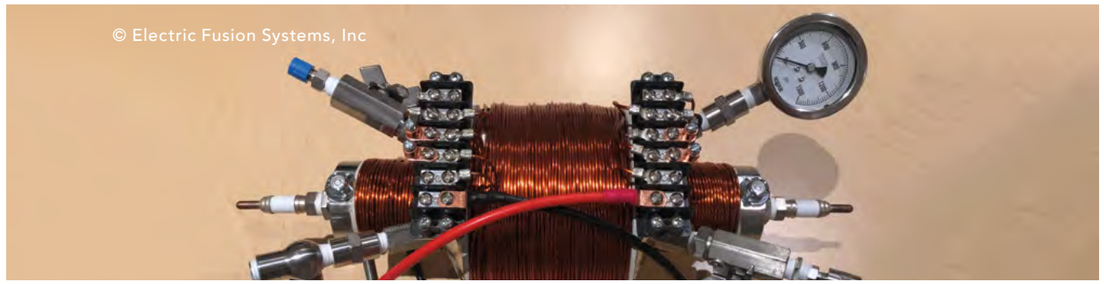
Location	Gavirate, Italy
Contact Details	info@Deutelio.com
Year founded	2022
Founder Names	Francesco Elio, Filippo Elio
Primary target markets	Electricity generation, Industrial Heat, District heating and electricity
Total declared funding to date	$534,300
Employees (incl. full time consultants)	2
General approach	Magnetic confinement
Specific approach	Poloidal magnetic confinement with shielded supports of the coil trapped inside the plasma, e.g. Levitron, Spherator, Intrap, LDX
Fuel Source	DD
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	**2027**: first nuclear D-D pilot power plant 10 MW for heat production. **2028**: sales for district heating, food industry, agriculture green houses and pools. **2032**: upgrade for electricity generation.
Anticipated MWe of your commercial operating facility	30 MWe
Milestones in past 12 months	Quotations for the supply of the vessel, copper magnets, support structure, power supply and basic plasma diagnostics of the small prototype. Assessment of the plasma confinement by particle path analyses and resistive MHD modelling. Establishment of collaborations with research institutions.



ELECTRIC FUSION SYSTEMS, INC.

Electric Fusion Systems was formed out of the founders' mutual investigations of proton-lithium fusion and insights on how to virtually eliminate the coulomb barrier with Rydberg matter. It uses a supercritical dense liquid metal fuel condensate to create an ultra-low cost (<$5/MWh) direct-to-electricity scalable aneutronic fusion power generator.

Location	Broomfield, Colorado, USA
Contact Details	info@electricfusionsystems.com
Year founded	2020
Founder Names	Ken E. Kopp and Ryan S. Wood
Primary target markets	Electricity generation, Space propulsion, Off-grid energy, Compact portable power 1-50kW
Total declared funding to date	$400,000
Employees (incl. full time consultants)	5
General approach	Rydberg matter fuel-based fusion, not traditional fusion concept
Specific approach	Pulsed magneto-plasma pressurized confinement
Fuel Source	Proton-Lithium-7
Planned energy capture approach	Direct electricity (energy) capture and conversion
Pilot plant timescale	2023
Anticipated MWe of first commercial operating facility	5 kilowatts to 100 megawatts depending on number of cartridges and modules.
Milestones in past 12 months	Created heavy Rydberg matter room temperature stable liquid fusion fuel condensate. Filed 2nd patent.
Key collaborators/partners	Voss Scientific, Energy Research Center, Brookline Consultants
Recent spin outs/patents/commercial innovations	Magnetohydrodynamic Cavitation Fusion Energy Generator PCT/US2022/53859 Aneutronic Fusion Plasma Reactor and Electric Power Generator PCT/US2021/057875



ENN SCIENCE AND TECHNOLOGY DEVELOPMENT CO., LTD.

ENN is committed to generating fusion energy in an environment-friendly and cost-effective manner. A number of devices are being designed and built to support our vision for commercial ST p-11B fusion.

Location	Langfang, China
Contact Details	qixudong@enn.cn
Year founded	ENN Science and Technology Development Co., Ltd founded in 2006 ENN Fusion Technology R&D Center founded in 2018
Founder Names	Yusuo WANG
Primary target markets	Electricity generation
Total declared funding to date	$400,000,000
Employees (incl. full time consultants)	150
General approach	Magnetic confinement
Specific approach	Spherical tokamak
Fuel Source	pB11
Planned energy capture approach	Direct energy conversion
Anticipated MWe of your commercial operating facility?	200MWe
Pilot plant timescale	15 years
Interim plants or facilities planned	The existing spherical tokamak EXL-50 will be upgraded to EXL-50U by the end of 2023. Then our major activities are arranged in three phases. In Phase I, a spherical torus research and development platform will be built to conduct a feasibility study on p-11B fusion in a spherical torus from scientific and engineering perspectives. Construction of the next generation device EHL-2 is scheduled to complete by 2026. The main technologies issues including but not limited to high heat load materials, high power supply, high efficient ion heating, high temperature superconductor manufacture, low aspect ratio engineering and advanced divertor will be studied. In Phase II, the plasma parameters will be increased, engineering constraints will be explored to meet requirements for fusion reactors, which will include EHL-3A and EHL-3B. In Phase III, cost reduction strategies will be developed, paving the way for commercial ST p-^{11}B fusion.
Milestones in past 12 months	ENN created the roadmap for Proton-boron fusion based on spherical torus and began to upgrade the existing device EXL-50 and design EHL-2.
Recent company investments	Upgraded the existing device EXL-50 to EXL-50U.
Key collaborators/partners	Peking University, Southwestern Institute of Physics, Academy of Science Institute of Plasma Physics ASIPP , Xi'an Jiaotong University, University of Science and Technology of China (USTC)
Recent Published papers	[1] Fusion reactivities with drift bi-Maxwellian ion velocity distributions, Plasma Phys. Control. Fusion 65 (2023) 055019. [2] Solenoid-free current drive via ECRH in EXL-50 spherical torus plasmas, Nucl. Fusion, 62 (2022) 086047. [3] A Study of the Requirements of p-11B Fusion Reactor by Tokamak System Code, Fusion Science and Technology, 78:2 (2022). 149-163.

© ENN

能量奇点
ENERGY SINGULARITY

ENERGY SINGULARITY FUSION POWER TECHNOLOGY

Energy Singularity was founded in 2021 in Shanghai, China. We are focusing on the R&D of high-field, high-confinement and compact tokamak with HTS magnets.

Location	Pudong, Shanghai, China
Contact Details	bd@energysingularity.cn
Year founded	2021
Founder Names	Zhao Yang
Primary target markets	Electricity generation
Total declared funding to date	$112,418,000
Employees (incl. full time consultants)	80
General approach	Magnetic confinement
Specific approach	Tokamak
Fuel Source	DT
Planned energy capture approach	Lithium neutron ‘blanket’
Anticipated MWe of your commercial operating facility?	~100MWe

EX-Fusion

FIA MEMBER

EX-FUSION

EX-Fusion is the first and only full-stack laser fusion company from Japan. Currently the company is focused on the development of laser control technologies as well as adaptive optics suited for high power laser operation. It aims to have a commercial laser fusion plant operational by 2035.

Location	Osaka, Japan (Head Office); Shizuoka, Japan (Hamamatsu Development Center)
Contact Details	info@ex-fusion.com
Year founded	2021
Founder Names	Dr. Kazuki Matsuo, Dr. Yoshitaka Mori, and Dr. Shinsuke Fujioka
Primary target markets	Electricity generation, Space propulsion, Hydrogen/ clean fuels
Total declared funding to date	$1,000,000
Employees (incl. full time consultants)	17
General approach	Inertial confinement
Specific approach	Laser-driven inertial confinement
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	2035 for grid level competitive commercial electricity production
Anticipated MWe of your commercial operating facility?	200MWe (by 2035), 1.4GWe (by 2045)
Interim plants or facilities planned	-2025: EX-Fusion 1kJ Prototype Laser Demonstrator -2029: EX-Fusion 5kJ Technical Demo Facility -2035: EX-Fusion (XF-200) 200MWe Commercial-grade Fusion Plant -2045: EX-Fusion (XF-1400) 1.4GWe Highly Competitive Large-scale Commercial Fusion Plant
Milestones in past 12 months	Successful target tracking experiment with 98% accuracy for the laser to track the fuel target
Recent company investments	Investing in a new facility for laser development, testing and experimentation in Hamamatsu (TBA around winter 2023)
Key collaborators/partners	Osaka University, GPI (The Graduate School for the Creation of New Photonics Industries)
Recent spin outs/patents/commercial innovations	Patent related to laser control scheme for cutting carbon fiber reinforced plastic (CFRP) for automotive parts. (To be used by auto manufacturers for EV production)

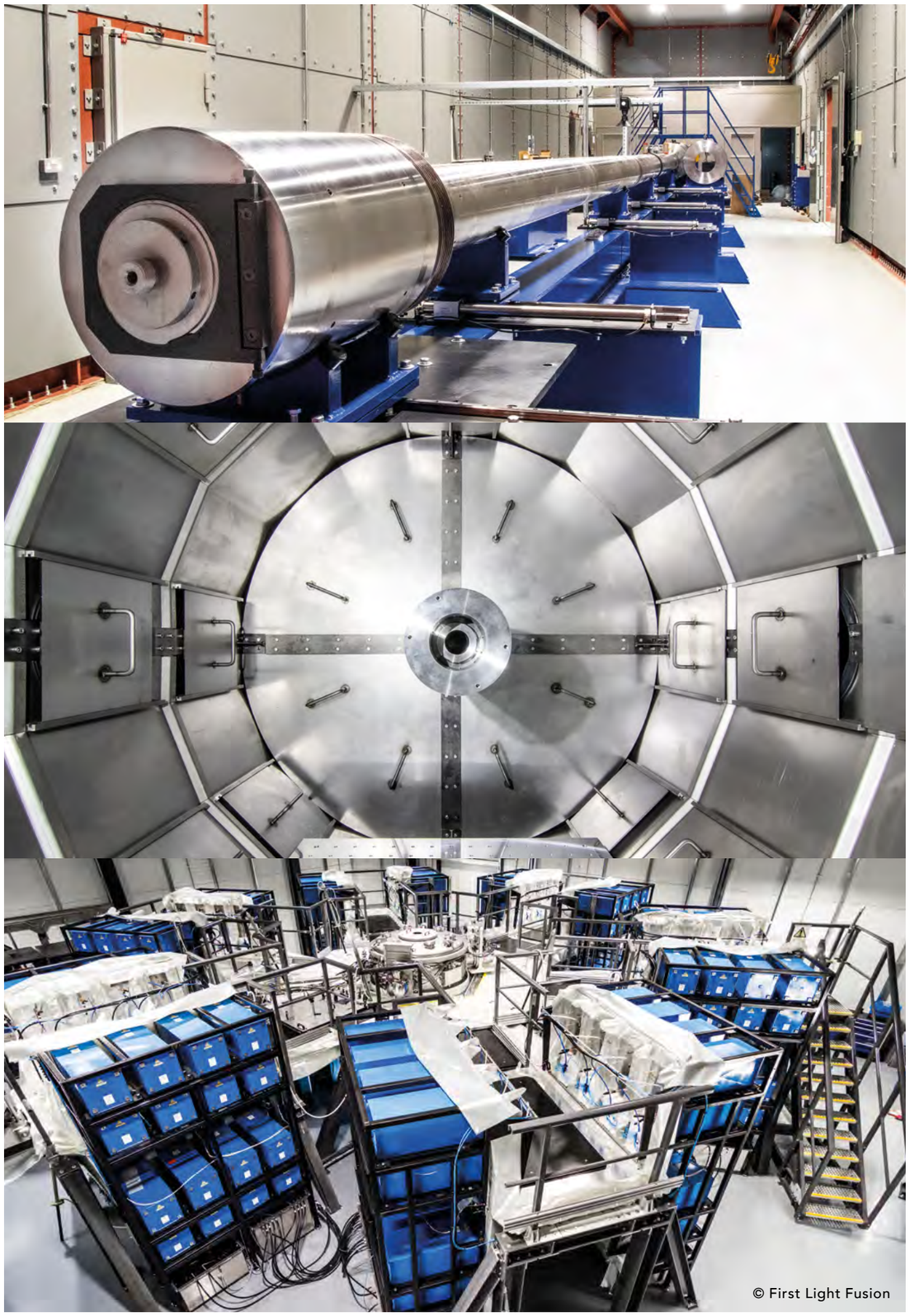
first light

FIA MEMBER

FIRST LIGHT FUSION

Oxford University's fusion spinout is on a mission to solve the problem of fusion power with the simplest machine possible, using its unique ICF amplifier technology. This simplicity maximises scalability by enabling deployment via existing value chain, maximising both shareholder value and global impact of fusion power.

Location	Oxford, UK
Contact Details	enquiries@firstlightfusion.com
Year founded	2011
Founder Names	Dr Nicholas Hawker, Prof Yiannis Ventikos
Primary target markets	Electricity generation
Total declared funding to date	$97,000,000
Employees (incl. full time consultants)	93
General approach	Inertial confinement
Specific approach	Shock-driven inertial confinement
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	2032
Anticipated MWe of your commercial operating facility?	>60MWe
Interim plants or facilities planned	M4 gain demonstrator PP machine
Milestones in past 12 months	Fusion via four discrete amplifier designs
Recent company investments	Expanded operations to accommodate 150 employees
Key collaborators/partners	Universities: Imperial, Oxford, York, Loughborough. Companies: IDOM, Machine Discovery, Engie National Labs: UKAEA, Canadian Nuclear Laboratories, Sandia
Recent spin outs/patents/ commercial innovations	Four new patent family applications
Recent published Papers	[1] Electronic density response of warm dense matter. Physics of Plasmas. Volume 30, Issue 3. 2023. [2] Imaginary-time correlation function thermometry: A new, high-accuracy and model-free temperature analysis technique for x-ray Thomson scattering data. Physics of Plasmas. Volume 30, Issue 4. 2023. [3] Scaling of pulsed power produced convergent shockwaves in insulators kA to MA. Bulletin of the American Physical Society. 64th Annual Meeting of the APS Division of Plasma Physics. 2022. [4] Experimental measurement of planarity of a 1 TPa shock on exit from a shock amplification system. Bulletin of the American Physical Society. 64th Annual Meeting of the APS Division of Plasma Physics. 2022.



FOCUSED ENERGY

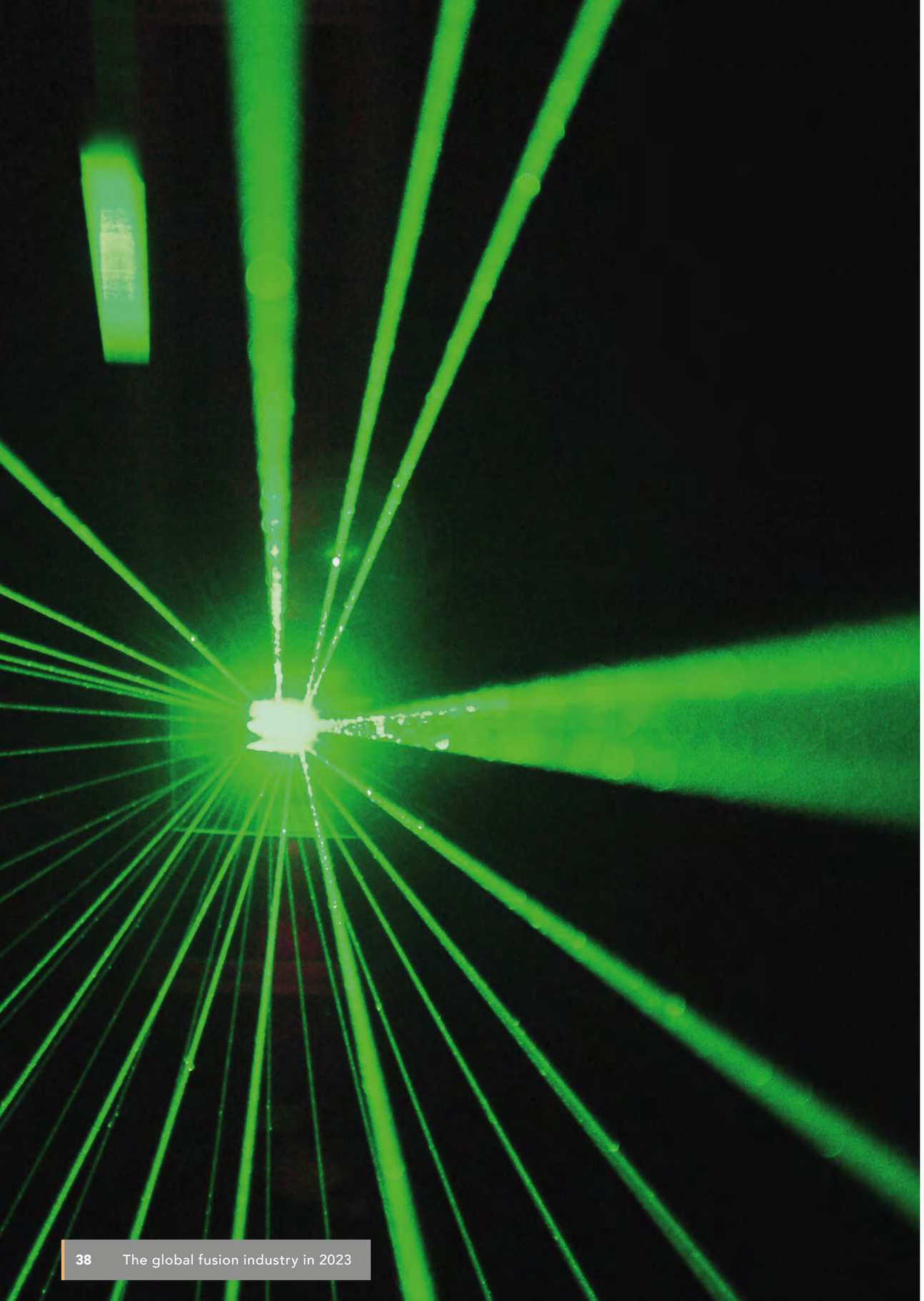
Focused Energy is a US/German startup. The company aims to use the best talent on both sides of the Atlantic to develop fusion as a clean energy source based on laser technology.

Location	Austin Texas, USA Darmstadt, Germany
Contact Details	info@focused-energy.world
Year founded	2021
Founder Names	Thomas Forner, Markus Roth
Primary target markets	Electricity generation
Total declared funding to date	$82,000,000
Employees (incl. full time consultants)	45
General approach	Inertial confinement
Specific approach	Laser-driven inertial confinement
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2038
Anticipated MWe of your commercial operating facility?	800 MWe
Key collaborators/partners	University of Texas, Technische Universitat Darmstadt, Extreme Light Infrastructure Prague, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Trumpf, Leonardo, Fraunhofer ILT and GSI Helmholtzzentrum für Schwerionenforschung

FUSE

Fuse is building Next Generation Pulsed Power (NGPP) machine based on the success of the Z machine at Sandia. Currently assembling the world's first and highest power driver (1TW) and operating a pulsed neutron generator licensed to produce >10^13 thermonuclear neutrons. Fuse is the only US company committed to MagLIF.

Location	Palo Alto, California, USA; Napierville, Quebec, Canada
Contact Details	hello@f.energy
Year founded	2019
Founder Names	JC Btaiche
Primary target markets	Electricity generation, Off-grid energy
Total declared funding to date	$18,000,000
Employees (incl. full time consultants)	20+
General approach	Magneto-inertial
Specific approach	Magnetized Liner Inertial Fusion (MagLIF)
Fuel Source	DT
Planned energy capture approach	Molten salt (FLiBe) with heat exchanger
Pilot plant timescale	2030s
Anticipated MWe of first commercial operating facility	~300MW
Interim plants or facilities planned	We are currently designing a 15TW intermediate user facility with the objective of running 1,000 shots per year allowing for rapid iteration and technically high-risk experiments that often drive innovation. The facility would be the world's first Next Generation Pulsed Power fusion facility based on Impedance Matched Marx Generator (IMG) architecture.
Milestones in past 12 months	– Producing the highest thermonuclear neutron yield in the private sector. – Design and simulation of world's first and highest power Impedance Matched Marx Generator (IMG)
Key collaborators/partners	L3 Harris, Voss Scientific, University of Nevada Reno, Institute of National Scientific Research
Recent spin outs/patents/ commercial innovations	License to operate up to 10^13 neutrons year.
Recent published papers	https://iopscience.iop.org/article/10.1088/2058-6272/ac78cc https://iopscience.iop.org/article/10.1088/1361-6587/ac7b49



FIA MEMBER

GAUSS FUSION

GAUSS FUSION

Gauss Fusion is a European green technology start-up aiming to produce renewable, clean fusion energy as the ultimate base-load power renewable in a solar-wind-fusion triad. It was founded in 2022 by medium-sized companies from France, Germany, Italy, and Spain, all of them with industrial expertise in fusion technologies.

Location	Hanau, Germany; Garching, Germany
Contact Details	info@gauss-fusion.com
Year founded	2022
Founder Names	Founded from industry: Alcen, Bruker, Hofima (ASG Superconductor), IDOM, RI Research Instruments
Primary target markets	Electricity generation
Total declared funding to date	$8,550,000
Employees (incl. full time consultants)	10
General approach	Magnetic confinement
Specific approach	Tokamak, Stellarator
Fuel Source	DT
Anticipated MWe of first commercial operating facility	100 MWe+
Key collaborators/partners	IPP Garching, KIT Karlsruhe, CERN, ENEA, CIEMAT

GENERAL ATOMICS

An American energy and defense corporation headquartered in San Diego, California, specializing in research and technology development. This includes physics research in support of nuclear fission and nuclear fusion energy.

Location	San Diego, California, USA
Contact Details	Zabrina.Johal@ga.com
Year founded	Founded in 1955, commercial fusion efforts began in 2022
Founder Names	Frederic de Hoffmann with assistance from notable physicists Edward Teller and Freeman Dyson
Primary target markets	Electricity generation
Total declared funding to date	$113,000,000
Employees (incl. full time consultants)	40 dedicated to commercial fusion effort (12,500 in total)
General approach	Magnetic confinement
Specific approach	Advanced Tokamak
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	2030s
Anticipated MWe of first commercial operating facility	200 MWe
Milestones in past 12 months	Conceptual design of GA modular blanket
Recent published papers	[1] General Atomics Roadmap for an Advanced Tokamak Fusion Pilot Plant, Bulletin of the American Physical Society, BM10.8, Oct. 17 (2022), https://meetings.aps.org/Meeting/DPP22/Session/BM10.8 [2] A dual-cooled fusion blanket using SiC-based structures, Fusion Engineering and Design 180 (2022) 113155, https://doi.org/10.1016/j.fusengdes.2022.113155

FIA MEMBER

GENERAL FUSION

General Fusion is pursuing a fast, practical path to bring fusion power to the market by the 2030s using its proprietary Magnetized Target Fusion (MTF) technology.

Locations	Vancouver, Canada; London, UK; Tennessee, USA
Contact Details	info@generalfusion.com
Year founded	2002
Founder Names	Dr Michel Laberge
Primary target markets	Electricity generation
Total declared funding to date	$300,000,000+
Employees (incl. full time consultants)	150
General approach	Magneto-inertial
Specific approach	Magnetized Target Fusion
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	Underway: MTF machine – LM26 – to be built in Richmond, B.C. LM26 is designed to achieve fusion conditions of over 100 million degrees Celsius by 2025, with a goal of achieving breakeven by 2026. The data gathered from LM26 will be incorporated into the design of the company's planned near-commercial machine in the UK. 2030s: First commercial fusion power plant
Anticipated MWe of first commercial operating facility	Approx. 230 MWe from two machines operating in-tandem
Milestones in past 12 months	– Demonstrated plasma energy confinement times, plasma temperatures, and compression system performance that support meeting the company's goal of 10 keV (100 million degrees Celsius) in our MTF machine. – Selected for two new funding awards through the Office of Fusion Energy Science's Innovation Network for Fusion Energy program. The awards will advance MTF for use in commercial fusion power plants through collaboration with the Savannah River National Laboratory and Oak Ridge National Laboratory. – Signed a collaborative agreement with UKAEA to kick off projects to advance the commercialization of magnetized target fusion energy. – Partnered with Canadian Nuclear Laboratories to pursue a series of joint projects to accelerate the deployment of commercial fusion power in Canada.

Recent company investments	General Fusion relocated and expanded its headquarters to Richmond, B.C. The new facility will provide space for General Fusion's LM26 MTF demonstration machine designed to achieve fusion conditions of over 100 million degrees Celsius by 2025, with a goal of achieving breakeven by 2026.
Key collaborators/partners	Selected partners and suppliers: Canadian Nuclear Laboratories, General Atomics, University of Illinois, McGill University, Oakridge National Laboratory, Princeton Plasma Physics Laboratory, Queen's University, Savannah River National Laboratory, Simon Fraser University, TRIUMF, United Kingdom Atomic Energy Authority, Uppsala University and University of Wisconsin Market Development Advisory Committee: ACEN, Bruce Power, Duke Energy, Eneco, E.ON UK, Southern Company, Tennessee Valley Authority, H2 Green Steel, Renexia
Recent spin outs/patents/commercial innovations	170 patents and patents pending
Recent published papers	Magnetohydrodynamics Solver for a Two-Phase Free Surface Flow Developed in OpenFOAM. Victoria Suponitsky, Ivan V. Khalzov, and Eldad J. Avital (2022).

FIA MEMBER

HB11 ENERGY HOLDINGS

HB11 Energy aims to create a new source of clean, safe and reliable energy using laser technology to fuse Hydrogen and Boron-11.

Location	Sydney, Australia
Contact Details	contact@hb11.energy
Year founded	2017
Founder Names	Heinrich Hora, Warren McKenzie, Jan Kirchhoff
Primary target markets	Electricity generation, Hydrogen/clean fuels, Industrial heat
Total declared funding to date	$5,100,000
Employees (incl. full time consultants)	10
General approach	Non-thermal laser fusion
Specific approach	Direct laser-driven pB11
Fuel Source	pB11
Planned energy capture approach	Direct energy conversion
Pilot plant timescale	2030s
Anticipated MWe of first commercial operating facility	300-500 MWe
Milestones in past 12 months	- Five experimental campaigns demonstrating pB11 fusion (on international laser facilities) - Proton energies above 50MeV - Q = 0.01% - Demonstrated target nanofabrication capability
Key collaborators/partners	- CLPU Salamanca (Spain) - ILE Osaka (Japan) - Australian Nuclear Science and Technology Organisation (ANSTO, Australia) - PROBONO network (Europe).
Recent spin outs/patents/ commercial innovations	HB11 Energy USA LLC (US subsidiary)
Recent published Papers	[1] Path to Increasing p-B11 Reactivity via ps and ns Lasers - https://doi.org/10.1155/2022/2355629 [2] HB11 Understanding Hydrogen-Boron Fusion as a New Clean Energy Source - https://link.springer.com/article/10.1007/s10894-023-00349-9 Full list of papers here: https://hb11.energy/technical-papers/

HELICAL FUSION CO., LTD.

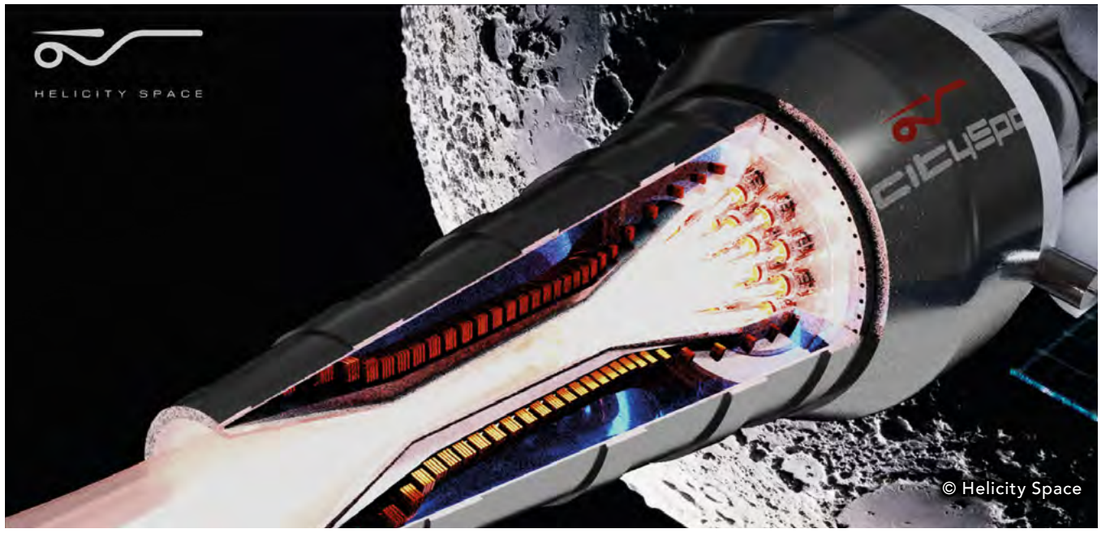
Helical Fusion Co., Ltd. is Japan's first startup aiming for the early realization of fusion energy using magnetic confinement of high-temperature plasmas.

Location	Tokyo, Japan; Newark, Delaware, USA (subsidiary)
Contact Details	contact@helicalfusion.com
Year founded	2021
Founder Names	Dr. Junichi Miyazawa, Takaya Taguchi, Dr. Takuya Goto, Prof. Nagato Yanagi
Primary target markets	Electricity generation
Total declared funding to date	$6,500,000
Employees (incl. full time consultants)	10
General approach	Magnetic confinement
Specific approach	Stellarator
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	By 2034
Anticipated MWe of first commercial operating facility	50 - 100 MWe
Interim plants or facilities planned	Planning to construct and operate "non-nuclear" prototype before our first 50 MWe Fusion Pilot Plant (FPP) for the comprehensive demonstration of various new technologies, with a reduced device size compared with the FPP.
Milestones in past 12 months	Raised 850 mil. JPY in total and successfully started collaboration with Japanese universities and national institutes.
Key collaborators/partners	National Institute for Fusion Science, Tohoku Univ., Aoyama-gakuin Univ., Tokushima Univ., SONY, KDDI, Mitsui Kinzoku, Canon
Recent spin outs/patents/innovations	HTS, High-manganese steel
Recent published papers	Development of Steady-State Fusion Reactor by Helical Fusion, Physics of Plasmas 30, 050601 (2023). DOI: 10.1063/5.0145222

HELICITYSPACE CORPORATION

Helicity Space Corporation is a privately funded company dedicated to developing compact fusion space propulsion and power systems of a spacefaring civilization. The vision is to enable space colonization and a clean Earth with fusion power & propulsion technology.

Location	Pasadena, California, USA
Contact Details	marta.calvo@helicityspace.com
Year founded	2018
Founder Names	Stephane Lintner, Marta Calvo, Setthivoine You
Primary target markets	Space propulsion
Total declared funding to date	$2,400,000
Employees (incl. full time consultants)	5
General approach	Magneto-intertial
Specific approach	Plectoneme
Fuel Source	DD
Planned energy capture approach	Lithium neutron 'blanket'
Anticipated MWe of your commercial operating facility?	300
Interim plants or facilities planned	Space propulsion prototype demonstration
Milestones in past 12 months	First Plasma achieved April 2023
Recent company investments	Built laboratory facilities
Key collaborators/partners	DOE via INFUSE public-private partnership, Caltech, UMBC, Swarthmore, Los Alamos National Laboratory, Limitless Space Institute



FIA MEMBER

HELION

HELION

Building the world's first fusion power plant to enable a future with unlimited clean electricity.

Location	Everett, Washington, USA
Contact Details	inquiries@helionenergy.com
Year founded	2013
Founder Names	David Kirtley, Chris Pihl, George Votroubek, John Slough
Primary target markets	Electricity generation
Total declared funding to date	$577,000,000
Employees (incl. full time consultants)	170
General approach	Magneto-intertial
Specific approach	Field Reversed Configuration
Fuel Source	DHe3
Planned energy capture approach	Direct energy conversion
Pilot plant timescale	2028
Anticipated MWe of your commercial operating facility?	At least 50 MWe
Interim plants or facilities planned	Helion is currently building its 7th fusion prototype, Polaris, which is expected to be the first fusion device to demonstrate electricity production from fusion. Helion also announced its plans to build the world's first fusion power plant, which will be operational in 2028. Microsoft will be the end customer of the electricity delivered from this WA-based facility.
Milestones in past 12 months	– Successfully operated pulsed power submodule at full power – Power Purchase Agreement between Helion, Microsoft, and Constellation to deliver fusion electricity in 2028 – Built out a new prototype capacitor manufacturing center – Built and began operations of a Polaris test section
Key collaborators/partners	Microsoft, Constellation, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Lawrence Livermore National Laboratory, Nevada National Security Site, Savannah River National Laboratory, Princeton Plasma Physics Laboratory

HORNE TECHNOLOGIES, INC.

Horne Technologies is a commercial fusion company targeting rapid and affordable advancement of fusion technology for near-term energy and neutron production. Horne Technologies' hybrid approach enables low-cost iteration with fusion-capable, continuously operating devices. energy.

Location	Longmont, Colorado, USA
Contact Details	hornetech@protonmail.com
Year founded	2008
Founder Names	Tanner Horne
Primary target markets	Electricity generation, Marine propulsion, Off-grid energy
Total declared funding to date	$2,000,000
Employees (incl. full time consultants)	4
General approach	Hybrid magnetic and electrostatic confinement
Specific approach	Spindle cusp, superconducting shielded-grid IEC
Fuel Source	DD, pB11
Planned energy capture approach	Hybrid system
Pilot plant timescale	3-5 years
Anticipated MWe of your commercial operating facility?	Less than 1 MWe
Interim plants or facilities planned	New facility completed 2022 which satisfies needs until pilot pçlant.
Milestones in past 12 months	All subsystems qualified and operational, experiments ongoing with positive indication. Upgraded cryogenic system capable of driving the HTS system at 20K. Two new ion injection systems developed and in use. Design and preparation for full power device.
Recent company investments	Major investments in cryogenics, software, facilities, and vacuum systems. Major investment and advancement in designs for manufacturing and scaling.
Recent spin outs/patents/ commercial innovations	US 11,482,342 B2 Issued

KYOTO FUSIONEERING

FIA MEMBER

KYOTO FUSIONEERING

Kyoto Fusioneering (KF) is a privately funded start-up headquartered in Japan. Our mission is to develop advanced technologies that are critical for commercial fusion, including systems for plasma heating, the fusion fuel cycle, and energy conversion. We support global fusion developers to accelerate the realization of fusion energy.

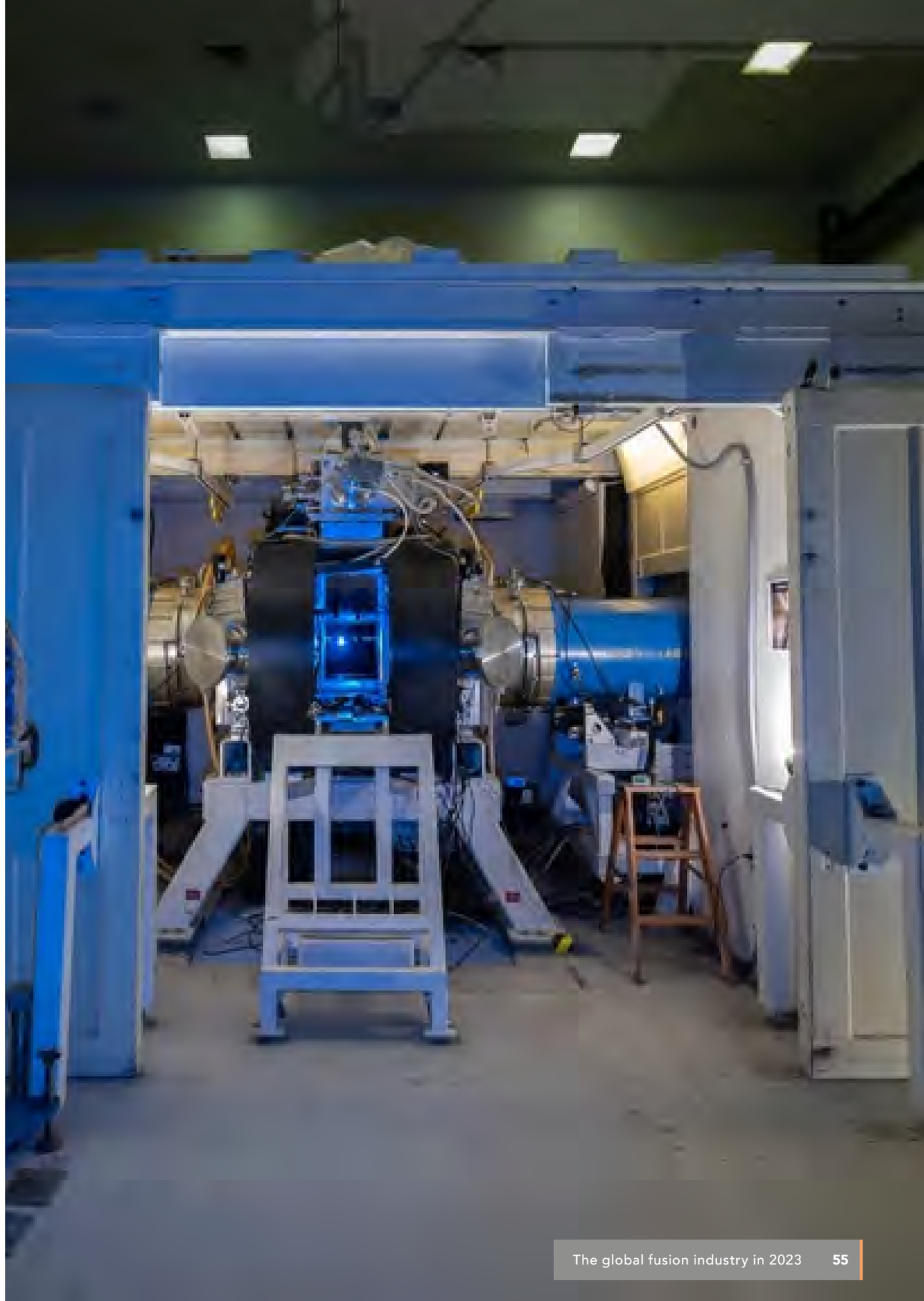
Location	Tokyo, Japan (Headquarters); Kyoto, Japan (Laboratory); Reading, UK (Regional office); Seattle, WA, USA (Regional office)
Contact Details	info@kyotofusioneering.com
Year founded	2019
Founder Names	Satoshi Konishi, Taka Nagao, Richard Pearson, Shutaro Takeda
Primary target markets	Electricity generation, Industrial heat
Total declared funding to date	$91,000,000
Employees (incl. full time consultants)	80
General approach	N/A
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	N/A - KF will be ready to provide technologies for developers pursuing construction of a fusion power plant by the end of the 2020s.
Interim plants or facilities planned	– UNITY-1 (UNique Integrated Testing facilitY for fusion thermal/power cycle) – UNITY-2 (UNique Integrated Testing facilitY for fusion fuel cycle)
Milestones in past 12 months	– Constructed the first SiCf/SiC (silicon carbide composite) module mock-up, which is a prototype of Kyoto Fusioneering's advanced SCYLLA tritium breeding blanket, and which is to be installed on UNITY-1. – Designed and built a lab-scale FLiBe test loop, and commenced FLiBe salt purification. – Gyrotron Factory Acceptance Test (FAT) completed for KF gyrotron to be installed on UKAEA's MAST-U tokamak. – Manufactured the first tritium-compatible roughing pump, to be tested with tritium in 2023. – Entered into collaboration agreement with UKAEA on advanced materials, with KF SiCf/SiC tolen now undergoing irradiation testing and material characterisation. – Signed MOU with Canadian Nuclear Labs (CNL) to develop tritium fuel technologies, and released the pre-conceptual design of a fusion power plant relevant fuel cycle (UNITY-2). – Completed detailed design of large-scale lithium-lead loop for UNITY-1, and placed order. – Designed and manufactured 9.5T magnet for 236GHz gyrotron, working with Japanese supply chain.
Recent company investments	– Invested in manufacture of the first tritium-compatible roughing pump (delivered, ready for testing). – Placed order for KF design of large-scale lithium-lead loop for UNITY-1 from Japanese supply chain (on order, to be installed on site in late 2023). – Invested in manufacture of 2-off dual-frequency gyrotrons for global customers. – Invested in manufacture of 9.5T magnet for prototype of 236 GHz gyrotron.
Key collaborators/partners	Kyoto University, Japan; UKAEA, UK; Tsukuba University, Japan; NIFS, Japan; QST, Japan; Osaka University, Japan; Canadian Nuclear Laboratories, Canada; Canon Electron Tubes & Devices
Recent published papers	[1] Kyoto Fusioneering's Mission to Accelerate Fusion Energy: Technologies, Challenges and Role in Industrialisation https://doi.org/10.1007/s10894-023-00346-y [2] Kyoto Fusioneering's Unique Integrated Testing Facility for Fusion Power Generation https://doi.org/10.1080/15361055.2023.2176689 [3] Overview of Kyoto Fusioneering's SCYLLA© ("Self Cooled Yuryo Lithium-Lead Advanced") Blanket for Commercial Fusion Reactors https://doi.org/10.1109/TPS.2022.3211410 [4] Development of Blanket and Intermediate Heat Exchanger with SiC Composite https://www.jspf.or.jp/Journal/PDF_JSPF/jspf2022_08/jspf2022_08-349.pdf

FIA MEMBER

LASERFUSIONX INC.

Advance direct drive laser fusion energy using the deep UV ArF laser the ArF laser.

Location	Springfield, Virginia, USA
Contact Details	laserfusionx@outlook.com
Year founded	2022
Founder Names	Stephen Obenschain
Primary target markets	Electricity generation
Total declared funding to date	$70,000
Employees (incl. full time consultants)	1 full time, two part time
General approach	Inertial confinement
Specific approach	Laser-driven inertial confinement
Fuel Source	DT
Planned energy capture approach	Lithium neutron ‘blanket’
Pilot plant timescale	16 years
Anticipated MWe of your commercial operating facility?	400 MW pilot power plant
Interim plants or facilities planned	Full scale ArF beamline (30 kJ), high gain ArF implosion facility (650 kJ)
Milestones in past 12 months	Publication in Physics of Plasmas advantages of ArF light for target physics and obtaining high gain at reduced laser energy.
Key collaborators/partners	PLEX LLC, Woodruff Scientific, NRL laser fusion
Recent published papers	https://www.optica-opn.org/home/articles/volume_34/june_2023/features/fusion_s_direct_drive/ https://pubs.aip.org/aip/pop/article/30/1/012701/2867678/The-importance-of-laser-wavelength-for-driving



LONGVIEW FUSION
ENERGY SYSTEMS

FIA MEMBER

LONGVIEW FUSION ENERGY SYSTEMS

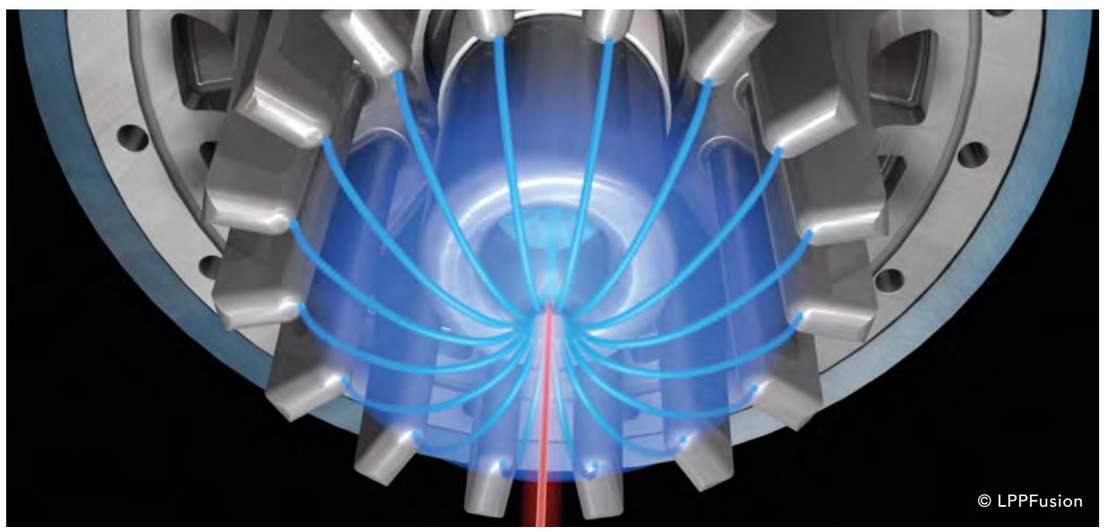
Longview is a technology and power plant integration company whose pathway to the energy market is through laser inertial confinement fusion plants. Our mission is commercialization of fusion energy.

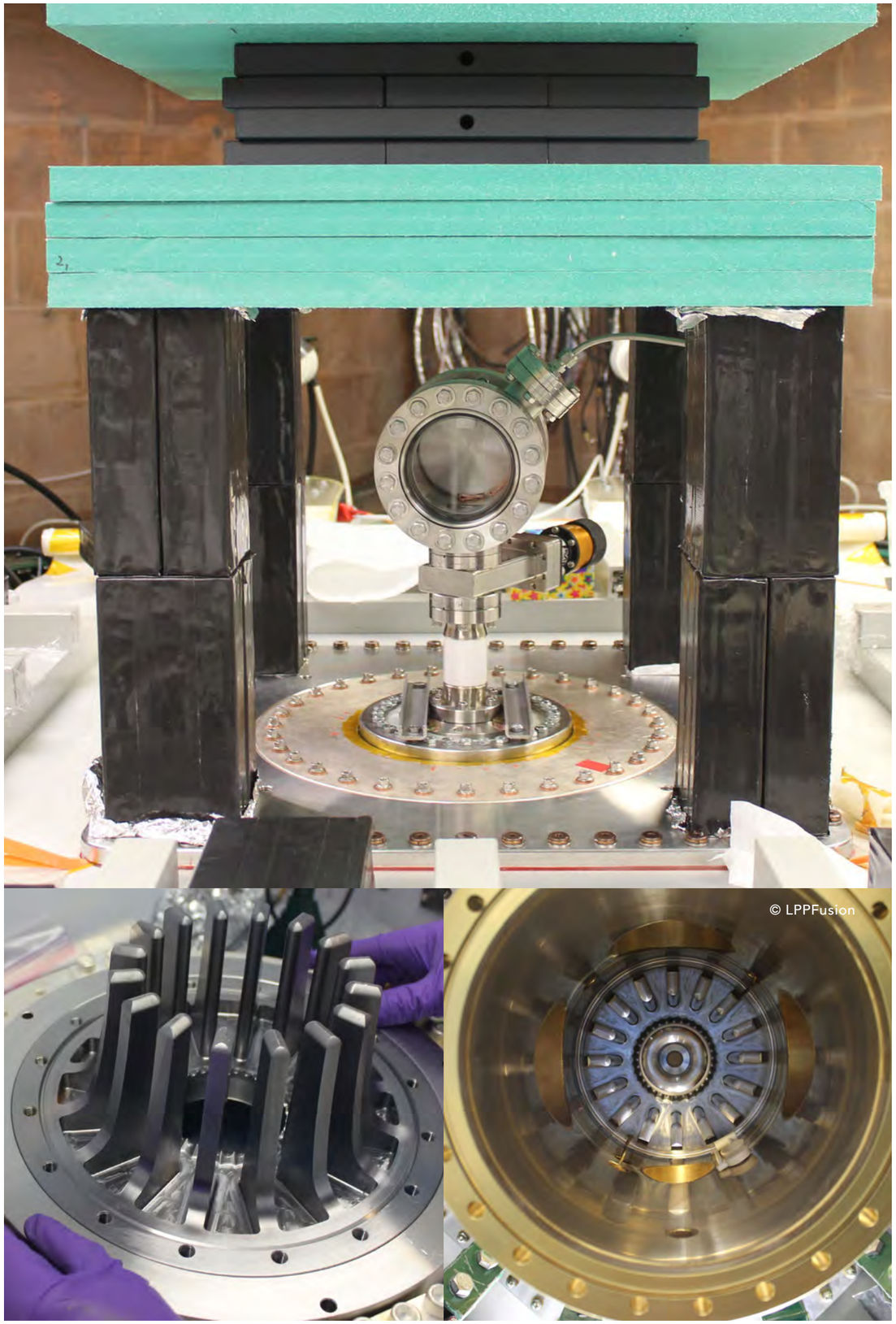
Location	Orinda, California, USA
Contact Details	info@longviewfusion.com
Year founded	2021
Founder Names	Edward Moses, Aaron Khandros, Igor Khandros
Primary target markets	Electricity Generation and Industrial Heat
Employees (incl. full time consultants)	10
General approach	Inertial confinement
Specific approach	Indirect Drive Laser Fusion. The design basis for Longview power plants builds from the >$100M Laser Inertial Fusion Energy (LIFE) program, developed by Lawrence Livermore National Laboratory (LLNL) and partners
Fuel Source	DT
Planned energy capture approach	Liquid lithium metal/alloy
Pilot plant timescale	Our commercialization goal is to design and build a Fusion Pilot Plant (FPP) to be operational in the mid-2030s based on fusion physics demonstrated on the National Ignition Facility (NIF). The FPP will initially operate at 50 MWe to the grid with 440 MWe capability.
Anticipated MWe of first commercial operating facility	Designs developed with range of 440 MWe to 1600 MWe to the grid
Interim plants or facilities planned	(i) Physics: Longview will be using the National Ignition Facility to demonstrate the required physics performance. Already, and uniquely among all fusion schemes, the NIF has demonstrated fusion energy with net scientific gain, Qsci>1, and multiple shots demonstrating a burning plasma and ignition using the same hohlraum-based approach being adopted by Longview. (ii) Rep-rated operation: A high-fidelity integrated laser-target engagement demonstration facility ("Big Shot") using a full-scale laser beamline and target injector, operating at the plant repetition rate
Recent Accomplishments	April 2023: Partnering agreement signed with Fluor Corporation to act as Longview's engineering and construction partner in designing and planning laser fusion energy for the global energy market. Dec 2022: Foundational patents awarded and filed in integrated plant operations and component sub-systems. Dec 2022: Fusion Qsci > 1 demonstrated on the NIF using the target design approach being adopted by Longview (indirect drive laser fusion).
Key collaborators/partners	DOE: Lawrence Livermore National Laboratory, Savannah River National Laboratory, Oak Ridge National Laboratory Industrial: Fluor Corporation, several laser systems technology partners, Marathon Petroleum Corporation, General Atomics Workforce development and education: University of Oklahoma, University of New Mexico, Prairie View A&M, University of Science and Arts Oklahoma Community guidance: Chickasaw Tribal Nation Legal and Regulatory: Pillsbury Winthrop Shaw Pittman LLC Economic analysis: Bates White
Recent published papers	US Patent (2022), "Inertial Confinement Fusion System Which Decouples Life-Limited Component From Plant Availability", https://tinyurl.com/uspatentlink. Co-authors of "Lawson Criterion for Ignition Exceeded in an Inertial Fusion Experiment", Physical Review Letters 129, 075001 (2022) and related papers.

LPPFUSION, INC.

Fusion R&D with a view to developing fastest route to fusion, using techniques based on the Dense Plasma Focus device and hydrogen-boron fuel.

Location	Middlesex, New Jersey, USA
Contact Details	fusionfan@lppfusion.com
Year founded	2003
Founder Names	Eric J. Lerner
Primary target markets	Electricity generation, Space propulsion, Marine propulsion, Off-grid energy, Industrial heat
Total declared funding to date	$10,000,000
Employees (incl. full time consultants)	4
General approach	Magnetic confinement
Specific approach	Dense Plasma Focus
Fuel Source	pB11
Planned energy capture approach	Direct energy conversion
Pilot plant timescale	2025
Anticipated MWe of your commercial operating facility?	5 MWe
Milestones in past 12 months	Developed new switches, increased peak current
Recent published papers	Focus Fusion: Overview of Progress Towards p-B11 Fusion with the Dense Plasma Focus https://link.springer.com/article/10.1007/s10894-023-00345-z



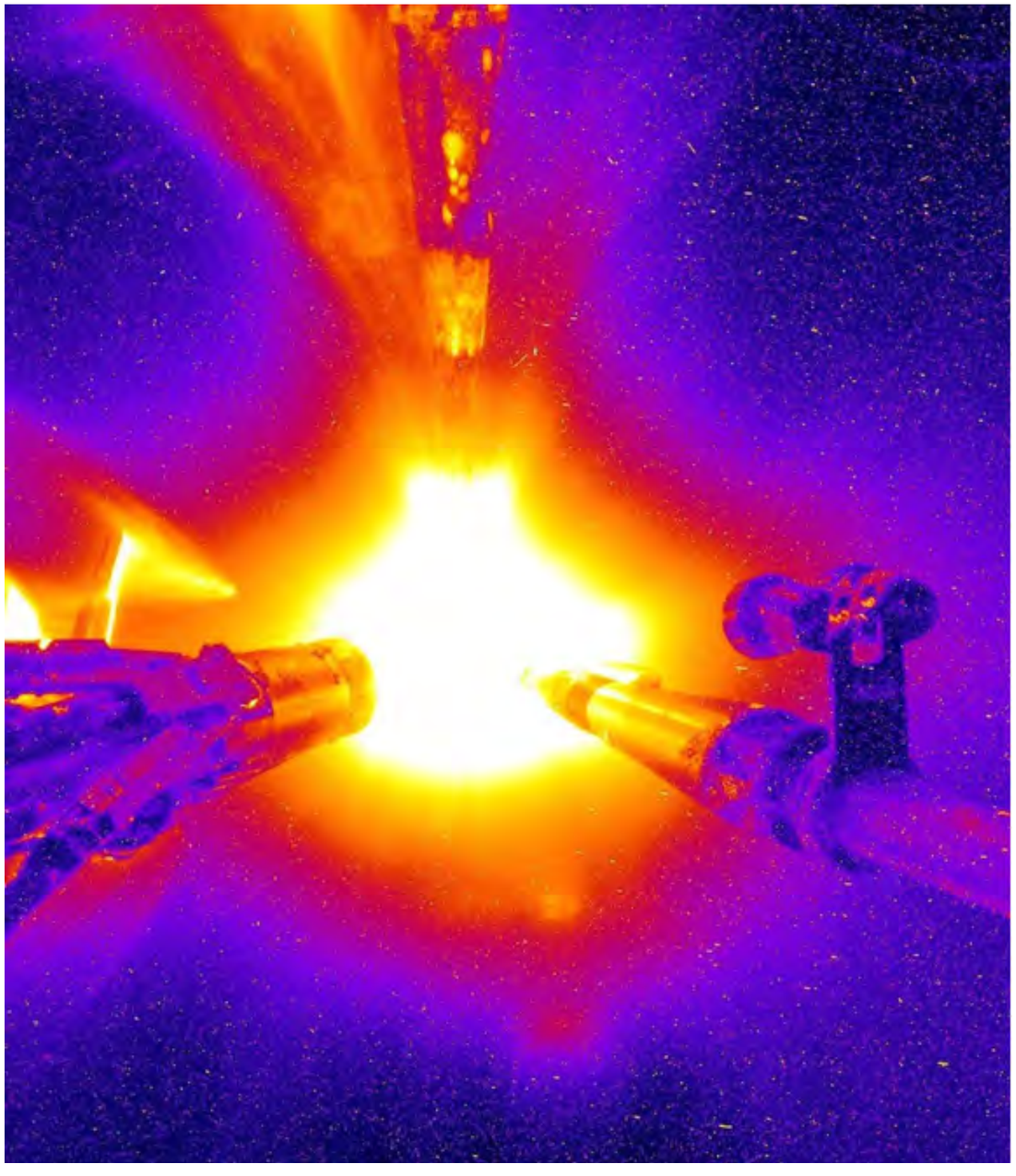


MAGNETO INERTIAL FUSION TECHNOLOGIES, INC.

MIFTI is trying to achieve fusion energy based on the idea of stabilized Staged Z-pinch where a high Z-liner implodes on a fusible target by multi-MA current machines. This approach will produce compact, low cost and scalable reactor, which it hopes will provide the fastest path to achieve fusion power.

Location	Tustin, California, USA
Contact Details	contact@miftec.com
Year founded	2009
Founder Names	Hafiz Rahman, Jerry Simmons, Mohammad Arshad, Norman Rostoker
Primary target markets	Electricity generation, Space propulsion, Medical, Hydrogen/clean fuels
Total declared funding to date	$12,000,000
Employees (incl. full time consultants)	6
General approach	Magneto-Inertial
Specific approach	Z-pinch
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2030
Anticipated MWe of your commercial operating facility?	50 MWe
Milestones in past 12 months	– Tested the idea on Linear Transformer Driver (LTD) and produced more than 10^8 fusion neutrons for 0.5 MA machine. – Tested the idea on different codes like Hydra and Flash. – Achieved crucial milestone: Lawson's Triple product n.T.t ~1019 (Kev.s.m3) – At the University of Nevada (Reno) 1MA machine, successfully achieved thermo-nuclear fusion with a 3x10^10 neutron yield – Experiments underway on 4MA Double Eagle machine to test the scaling for higher current.
Key collaborators/partners	University of California San Diego, University of Rochester, Lawrence Livermore National Lab
Recent spin outs/patents/commercial innovations	The same generator of much smaller size can be used to produce nuclear isotopes by neutron activation. These isotopes are used as nuclear medicines. Two patents are granted to date.

Recent published papers	[1] Staged Z-pinch modeling of high and low atomic number liners compressing deuterium targets using parameters of the Z pulsed power facility, Physics of Plasma, 28, 112701(2021). [2] Study of stability in a liner-on-target gas puff Z-pinch as a function of pre-embedded axial magnetic field, Phys. Plasmas 27, 012702 (2020). [3] Ar and Kr on deuterium gas-puff staged Z-pinch implosions on a 1-MA driver: Experiment and simulation, Phys. Plasmas 26,052706(2019).



MARVEL FUSION

Marvel Fusion pursues a non-thermal direct drive inertial confinement approach with the goal of commercialising fusion energy using low-neutronic fuels. Highly intense short-pulsed lasers and proprietary nanostructured fuel targets enable a highly efficient fusion process with a clear path to commercialization.

Location	Munich, Germany
Contact Details	info@marvelfusion.com
Year founded	2019
Founder Names	Moritz von der Linden, Dr. Georg Korn, Dr. Karl-Georg Schlesinger, Dr. Pasha Shabalin
Primary target markets	Electricity generation, Industrial heat
Total declared funding to date	$112,180,000
Employees (incl. full time consultants)	70
General approach	Inertial confinement
Specific approach	Laser-driven Direct Drive Inertial Confinement Fusion
Fuel Source	pB11
Anticipated MWe of your commercial operating facility?	200-1000 MWe
Interim plants or facilities planned	2027: Proof-of-concept Demonstration facility constructed
Milestones in past 12 months	German Federal Agency for Disruptive Innovation develops proprietary laser systems needed for Marvel Fusions technology 2,000 experiments conducted at leading laser facilities (Colorado State University, Texas Petawatt Laser, Extreme Light Infrastructure for Nuclear Physics, CALA of the Ludwig Maximilians University Munich), validating key physics aspects.
PRecent company investments	Upgrading the CALA facility
Key collaborators/partners	Siemens Energy, Thales, BASF, Ludwig Maximilians University of Munich, Extreme Light Infrastructure for Nuclear Physics
Recent published Papers	– High current ionic flows via ultra-fast lasers for fusion applications; https://doi.org/10.48550/arXiv.2212.12941 – Volume ignition of mixed fuel; https://doi.org/10.48550/arXiv.2302.06562 – Numerical validation of a volume heated mixed fuel reactor concept; https://doi.org/10.48550/arXiv.2306.03731 – Investigation of Proton Beam-Driven Fusion Reactions Generated by an Ultra-Short Petawatt-Scale Laser Pulse; https://doi.org/10.1155/2022/2404263

NEARSTAR FUSION INC.

NearStar Fusion is a Virginia based company developing magneto inertial confinement fusion power plants using hypervelocity plasma armature rail guns to drive pulsed fusion reactions. Our simple and modular approach will enable development of a utility scale power plant in a decade and performance growth to use advanced fusion fuels.

Location	Chantilly, Virginia, USA
Contact Details	amit@nearstarfusion.com
Year founded	2021
Founder Names	Doug Witherspoon, Chris Faranetta
Primary target markets	Electricity generation, Spacecraft propulsion
Total declared funding to date	$500,000
Employees (incl. full time consultants)	7
General approach	Magneto Inertial Confinement
Specific approach	Hypervelocity Gradient Field Fusion & Advanced Fuel Impact Fusion
Fuel Source	DT, DD, pB11
Planned energy capture approach	Lithium neutron 'blanket' for tritium breeding and advanced fuel direct energy conversion
Pilot plant timescale	10 years
Anticipated MWe of your commercial operating facility?	50 MWe to 1 GWe
Interim plants or facilities planned	Expanded test facility for high performance fusion driver development and experimental power plant.
Milestones in past 12 months	Plasma gun driver side injector under development, computer performance modelling being conducted
Key collaborators/partners	University of Alabama at Huntsville (UAH)

NK LABS, LLC

NK Labs, LLC, is an engineering company. We are developing muon-catalyzed fusion for production of clean energy and clean fuels. Our approach builds on decades of work by government labs worldwide and leverages recent developments in advanced materials and computational optimization.

Location	Cambridge, Massachusetts, USA
Contact Details	sales@nklabs.com
Year founded	2008
Founder Names	Ara Knaian, Seth Newburg
Primary target markets	Electricity generation, Medical, Hydrogen/clean fuels, Industrial heat, Tritium Production
Total declared funding to date	$2,500,000
Employees (incl. full time consultants)	20
General approach	Muon-catalyzed fusion
Specific approach	Muon-catalyzed fusion with high density fuel
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	2032
Anticipated MWe of first commercial operating facility	100 MWe
Milestones in past 12 months	– Measured fusion neutrons from muon-catalyzed D-D fusion in our system – Awarded plus-up funding by ARPA-E – Awarded approved experiment status at the Paul Scherrer Institute – Filed for patents on our core technology
Key collaborators/partners	ARPA-E, Fermilab, Paul Scherer Institute, University of Rochester Laboratory for Laser Energetics, York College
Recent published papers	[1] GEANT4 Simulation Package for Interactions Related to Muonic Atoms and Muon-Catalyzed Fusion (CF)., Presented at the International Conference on High Energy Physics (ICHEP), 2022 [2] Efficient modeling of particle transport through aerosols in GEANT4, Computer Physics Communications, Volume 278, 2022 [3] "Diamond Anvil Measurement of Muon Catalyzed Fusion," Open CHRISP Users Meeting, Villigen, Switzerland, January 2022, https://indico.psi.ch/event/12027/contributions/34046/attachments/20770/34165/Update%20to%20PSI%2001-26-2022.pdf [4] "Conditions for High-Yield Muon Catalyzed Fusion," Presented at the ARPA-E Summit, May 2022, https://arpa-e.energy.gov/sites/default/files/2022-08/Ara_Knaian.pdf

NOVATRON FUSION GROUP AB

Fusion power to the grid through industrialization of a novel fusion reactor concept - www. novatronfusion.com

Location	Alvik, Stockholm, Sweden
Contact Details	info@novatronfusion.com
Year founded	2019
Founder Names	Jan Jäderberg
Primary target markets	Electricity generation
Total declared funding to date	$3,205,000
Employees (incl. full time consultants)	25
General approach	Magnetic confinement
Specific approach	Mirror machine
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2036 - 2039
Anticipated MWe of your commercial operating facility?	1 - 1,5 MWe
Interim plants or facilities planned	2023: Novatron 1 - Validation of plasma confinement method 2026: Novatron 2 - Fusion conditions, DD-reactions detected 203X: Novatron 3 - Continuous fusion, DT-fuel, Q=1 203Y: Novatron 4 - Commercial viable fusion power plant blueprint
Milestones in past 12 months	– MHD and PIC-Simulations predicting a stable plasma confinement – Novatron specific, patented add-ons for increasing Tau-e and mitigate potential plasma disturbances
Recent company investments	Equipment and parts for the Novatron 1- EUR 700 000
Key collaborators/partners	NTG, Scanditronix, KTH, InnoEnergy, Tsukuba University, UK Culham Fusion Cluster

NT-TAO LTD

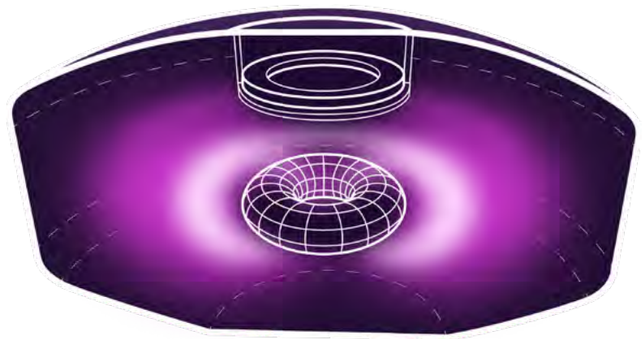
NT-Tao is focused on breakthrough compact fusion technology with the goal to democratize clean and affordable energy worldwide.

Location	Hod Hasharon, Israel
Contact Details	mail@nt-tao.com
Year founded	2019
Founder Names	Oded Gour-Lavie, Doron Weinfeld, Boaz Weinfeld
Primary target markets	Electricity generation, Off-grid energy, Industrial heat
Total declared funding to date	$28,000,000
Employees (incl. full time consultants)	18
General approach	Magnetic confinement
Specific approach	Modified Stellarator
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2030
Anticipated MWe of first commercial operating facility	10-20 MWe
Milestones in past 12 months	Third full prototype finished and in experimental stage.
Key collaborators/partners	Partnered with MOE and leading academic institutes to create the Israeli Fusion and Hot plasma Institute. Members of the Andlinger Center E-filliates.

OPENSTAR TECHNOLOGIES

OpenStar Technologies is developing the Levitated Dipole reactor concept. This unlocks rapid iteration cycles, inherently stable plasma physics, and ground-breaking high-temperature superconductor technologies within a framework of reliable magnetic confinement fusion. This results in cost-effective scaling of infrastructure and swift development pathways, ensuring fast and affordable risk retirement.

Location	Wellington, New Zealand
Contact Details	info@openstar.nz
Year founded	2021
Founder Names	Ratu Mataira-Cole
Primary target markets	Electricity generation
Total declared funding to date	$6,800,000
Employees (incl. full time consultants)	26
General approach	Magnetic confinement
Specific approach	Levitated Dipole
Fuel Source	Tritium suppressed DD
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	First reactors installed late 2020s
Anticipated MWe of your commercial operating facility?	~ 800 MWe for early D-D or D-He3 reactors
Interim plants or facilities planned	Ignited D-T reactor to prove out final details of plasma physics at fusion temperatures.
Milestones in past 12 months	– 5.2 metre vacuum vessel and 30 kW ECRH – system designed and purchased. – HTS power supplies tested to 1.4 kA. – HTS magnet winding machine successfully winding magnets.
Key collaborators/partners	Robinson Research Institute, Victoria University of Wellington



PRINCETON FUSION SYSTEMS

PFS is developing compact fusion reactors for modular and portable power systems. The Princeton FRC utilizes a novel configuration of rotating magnetic fields invented at the Princeton Plasma Physics Lab. The PFRC is uniquely dual-use for both terrestrial use and space power and propulsion.

Location	Plainsboro, New Jersey, USA
Contact Details	info@princetonfusionsystems.com
Year founded	Princeton Satellite Systems - 1992. dba Princeton Fusion Systems since 2017
Founder Names	Michael Paluszek, Marilyn Ham
Primary target markets	Off-grid energy
Total declared funding to date	$3,600,000
Employees (incl. full time consultants)	6
General approach	Magnetic confinement
Specific approach	Field Reversed Configuration
Fuel Source	DHe3
Planned energy capture approach	Brayton cycle
Pilot plant timescale	2030
Anticipated MWe of first commercial operating facility	1 MWe
Interim plants or facilities planned	The PFRC-3 facility is planned to demonstrate fusion-relevant plasma conditions using superconducting magnets. The follow-on facility, PFRC-4, is planned to demonstrate D-3He fusion and produce net electricity.
Recent company investments	New capacitors were installed on the PFRC-2 allowing a lower operating frequency of the rotating magnetic fields for improved ion heating.
Key collaborators/partners	PPPL, GE Vernova, University of Rochester, Princeton University, NREL, Qorvo
Recent published papers	[1] A Fusion-Propelled Transportation System to Produce Terrestrial Power Using Helium-3 From Uranus, AIAA SciTech 2023, DOI: 10.2514/6.2023-0555 [2] The Princeton Field-Reversed Configuration for Compact Nuclear Fusion Power Plants, J Fusion Energ 42, 4 (2023), DOI: 10.1007/s10894-023-00342-2

PROXIMA FUSION

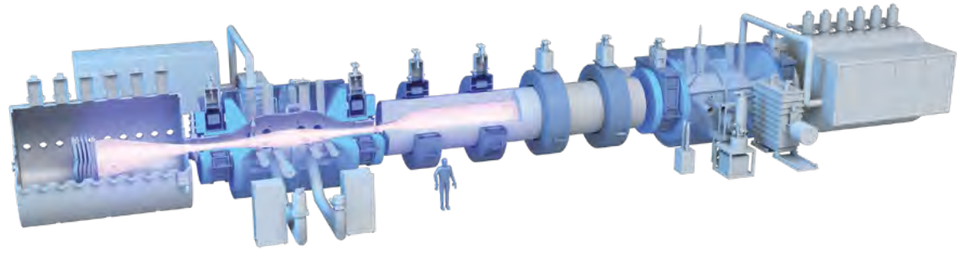
Proxima Fusion is aiming to commercialize fusion energy in the 2030s via optimized stellarator technology.

Location	Munich, Germany
Contact Details	info@proximafusion.com
Year founded	2023
Founder Names	Francesco Sciortino, Lucio Milanese, Jorrit Lion, Jonathan Schilling, Martin Kubie
Primary target markets	Electricity generation, Industrial heat
Total declared funding to date	$8,190,000
Employees (incl. full time consultants)	13
General approach	Magnetic confinement
Specific approach	Quasi-isodynamic stellarator
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2030s
Anticipated MWe of your commercial operating facility?	750MWe
Interim plants or facilities planned	Demonstration of scientific and technological milestones in "Proxima Alpha" in early 2030s
Key collaborators/partners	Max Planck Society Institute for Plasma Physics, MIT, Istituto Superior Tecnico Lisbon Karlsruhe Institute of Technology, Bilfinger Noell GmbH

REALTA FUSION

Realta Fusion is developing compact magnetic mirror technology as the lowest capex and least complex path to commercially competitive fusion energy. Realta is targeting the need to decarbonize industrial process heat for early adoption of fusion. The company spun out of an ARPA-e funded project at the University of Wisconsin.

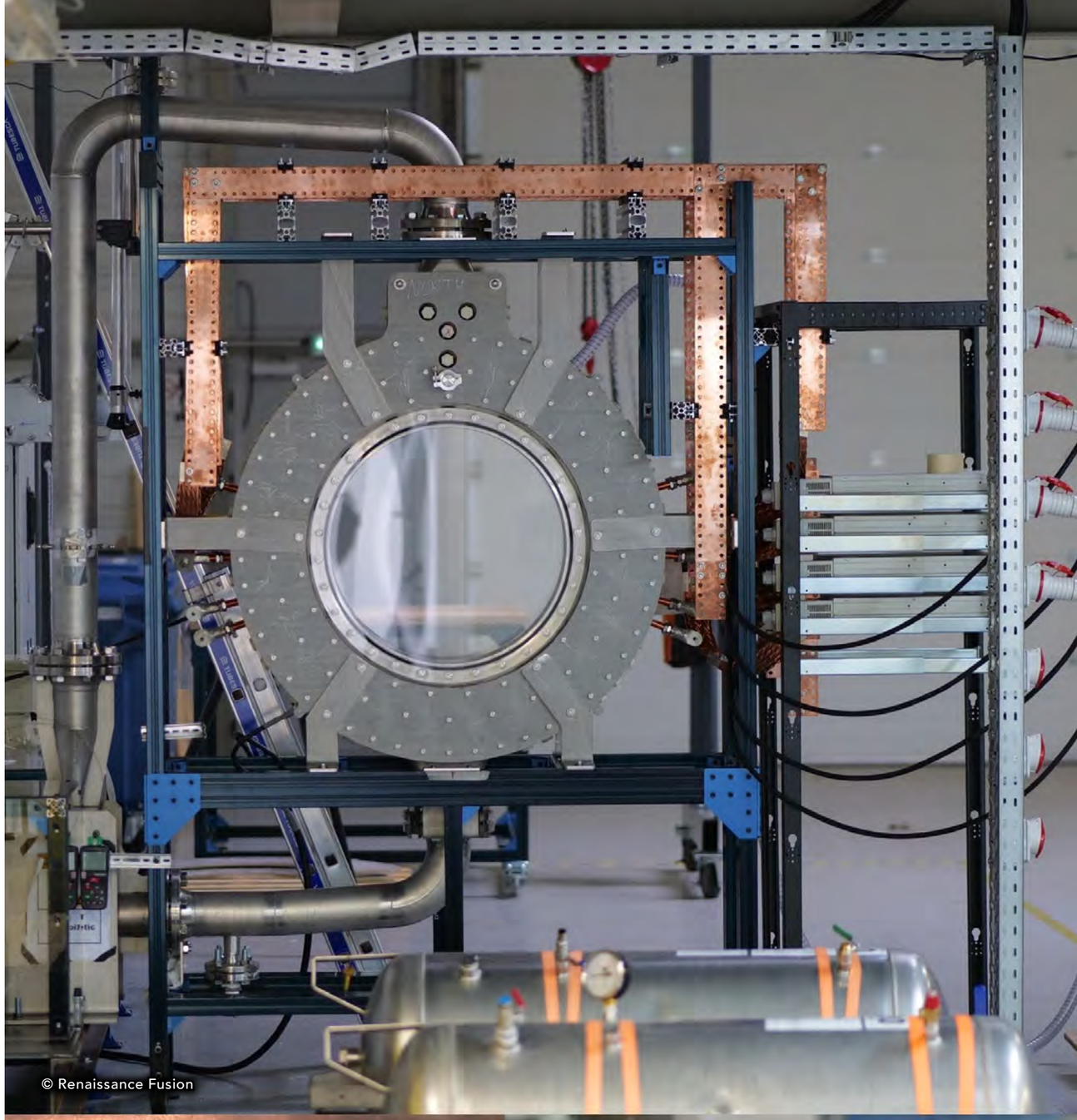
Location	Madison, Wisconsin, USA
Contact Details	info@realtafusion.com
Year founded	2022
Founder Names	Cary Forest, Kieran Furlong, Jay Anderson, Ben Lindley, Oliver Schmitz
Primary target markets	Off-grid energy, Industrial heat
Total declared funding to date	$12,000,000
Employees (incl. full time consultants)	5
General approach	Magnetic confinement
Specific approach	Magnetic mirror
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	10 years
Anticipated MWe of your commercial operating facility?	100 MWe
Interim plants or facilities planned	BEAM - Break-Even Axisymmetric Mirror. A simple mirror device that demonstrates net energy generating relevant conditions and can be a volumetric neutron source.
Key collaborators/partners	Department of Energy. Realta Fusion is one of the awardees in the Milestone-Based Fusion Development Program. The company spun out of an ARPA-e funded project at the University of Wisconsin-Madison.
Recent published papers	Fusion by beam ions in a low collisionality, high mirror ratio magnetic mirror. J. Egedal et al 2022 Nucl. Fusion 62 126053



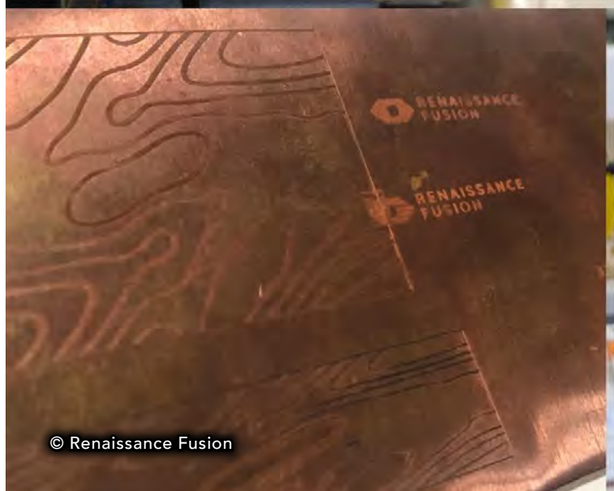
RENAISSANCE FUSION

Renaissance Fusion builds on the success of stellarator experiments, makes them reactor ready by quadrupling the magnetic field and simplifies them using proprietary High- Temperature Superconductors manufacturing and flowing liquid-metal walls.

Location	Fontaine, France
Contact Details	contact@renfusion.eu
Year founded	2021
Founder Names	Francesco Volpe
Primary target markets	Electricity generation
Total declared funding to date	$17,625,000
Employees (incl. full time consultants)	30
General approach	Magnetic confinement
Specific approach	Stellarator
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	2032
Anticipated MWe of your commercial operating facility?	1,000 MWe
Interim plants or facilities planned	Experimental reactor proving Q greater than 2 and continuous operations
Milestones in past 12 months	Liquid metal closed loop with induction pump, Design review on HTS machines
Recent company investments	Materials for HTS machines & Liquid demonstrator, various experimental devices
Key collaborators/partners	BPI France, CEA, CNRS, INRIA, Université de Lorraine, University of Houston, Universita della Tuscia
Recent spin outs/patents/commercial innovations	11 patents have been filed in April and June 2022



© Renaissance Fusion



© Renaissance Fusion

SHINE TECHNOLOGIES

SHINE is commercializing and industrializing near-term applications of fusion, like inspecting industrial components through neutron imaging and producing medical isotopes. These applications create tremendous social and economic value and allow us to build and practice the capabilities we believe are essential for deploying fusion energy to billions of people.

Location	Janesville, Wisconsin, USA; Fitchburg, Wisconsin, USA; Groningen, Netherlands
Contact Details	info@shinefusion.com
Year founded	2005
Founder Names	Greg Piefer, founder and CEO
Primary target markets	Electricity generation, Medical, testing for advanced industrial inspection; transmutation of nuclear waste
Total declared funding to date	$700,000,000
Employees (incl. full time consultants)	370
General approach	Phase 1: beam-solid target, Phase 2: beam-gas target, Phase 3: beam-plasma target, Phase 4: high temperature plasma. Hybrid electrostatic confinement is closest to what we are planning in the future
Specific approach	Magnetic-electrostatic confinement
Fuel Source	DT
Planned energy capture approach	Fission-fusion hybrid in phase 3 (if energy capture is valuable enough in the context of waste recycling). Lithium neutron blanket will most likely be our approach in phase 4.
Pilot plant timescale	Already done Phase 1; Phase 2 2024; Phase 3, 2030; Phase 4, 2040(ish).
Anticipated MWe of your commercial operating facility?	Phase 1: 10-1000 W, Phase 2: 1 MW, Phase 3: 10 MW, Phase 4: 100 MW
Interim plants or facilities planned	– At our Building One facility in Janesville, WI, we recently announced the launch of FLARE (Fusion Linear Accelerator for Radiation Effects) testing service, which will use high-energy fusion neutrons (14 MeV) to offer state-of-the-art radiation effects testing for defense and aerospace customers. – The Chrysalis, on our Janesville, WI campus, will be the home of our fusion-driven medical isotope production, including eight fusion systems. The facility is nearing completion and will use a hybrid fusion-fission system to produce thermal power equivalent of up to 1 MW.

	– Our Phoenix Imaging Center, located in Fitchburg, WI, is commercial and uses fusion technology to inspect industrial components through neutron imaging, radiation effects testing, and other forms of non-destructive testing.
Milestones in past 12 months	– Achieved profitability with Phase 1 testing business – Demonstrated neutron image quality equal to or better than reactors with fusion-technology approach – Cold commissioning completed on full-scale tritium-deuterium separation and purification system, hot commissioning expected to complete in June 2023 – Safety Evaluation Report (SER) issued by Nuclear Regulatory Commission (NRC) for the Chrysalis – Demonstrated advanced plasma window technology, allowing for high power density (>100 kW /cm2) particle beams to enter regions of more dense matter while minimizing pumping requirements – Deployed hot cells capable of processing a few hundred million doses per year of Lu-177, which will be produced in the Chrysalis.
Recent company investments	We are converting designated space in our Building One facility to be used for our FLARE testing service. We have completed acceptance testing of four of our current generation fusion systems, of which there will be eight when our Chrysalis fusion-driven medical isotope production facility is fully operational. Our investment totaled over $100 million.

Key collaborators/partners	Department of Energy, National Nuclear Security Administration, Department of Energy (Office of Science, Fusion Energy Science program), Argonne National Lab, Oak Ridge National Lab, Savannah River National Lab, Lawrence Livermore National Lab, Y-12 National Security Complex, Orano USA, Department of Energy ARPA-E, GE-Hitachi
Recent spin outs/patents/commercial innovations	SHINE filed 50 patent applications between May 2022 and May 2023 across a total of 24 patent families. 14 of these patent families were newly generated in this 12-month stretch. This represents a ~33% increase in total SHINE patent applications and granted patents, and a ~60% increase in total SHINE patent families.
Recent published papers	[1] A Plasma-Window Enhanced Accelerator-Based Deuterium-Tritium Neutron Generator System, Fusion Science and Technology (2023) [2] New ECR Source Ion Implanter with Advanced Wafer Temperature Control for Material Modification, MRS Advances (2022) 7: 1289-1294

FIA MEMBER

STELLAREX, INC.

Stellarex is a fusion energy technology development company, building on recent science and technology breakthroughs at several major fusion laboratories, research foundations and projects. Stellarex is focussed on the stellarator approach to magnetic fusion, leveraging a novel high temperature superconductor and a proprietary strategy for power and particle control.

Location	Princeton, New Jersey, USA
Contact Details	info@stellarex.energy
Year founded	2022
Founder Names	Richard Carty, Amitava Bhattacharjee, Michael Zarnstorff
Primary target markets	Electricity generation, Off-grid energy, Industrial heat
General approach	Magnetic confinement
Specific approach	Stellarator
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	SX1 - ignited, operational in 2030's
Anticipated MWe of first commercial operating facility	250 MWe
Interim plants or facilities planned	SX0 - Q > 1 in 2020's
Milestones in past 12 months	Company formation, IP strategy developed, detailed planning, pre-concept design activities
Recent spin outs/patents/commercial innovations	Magnet technology and power/particle control

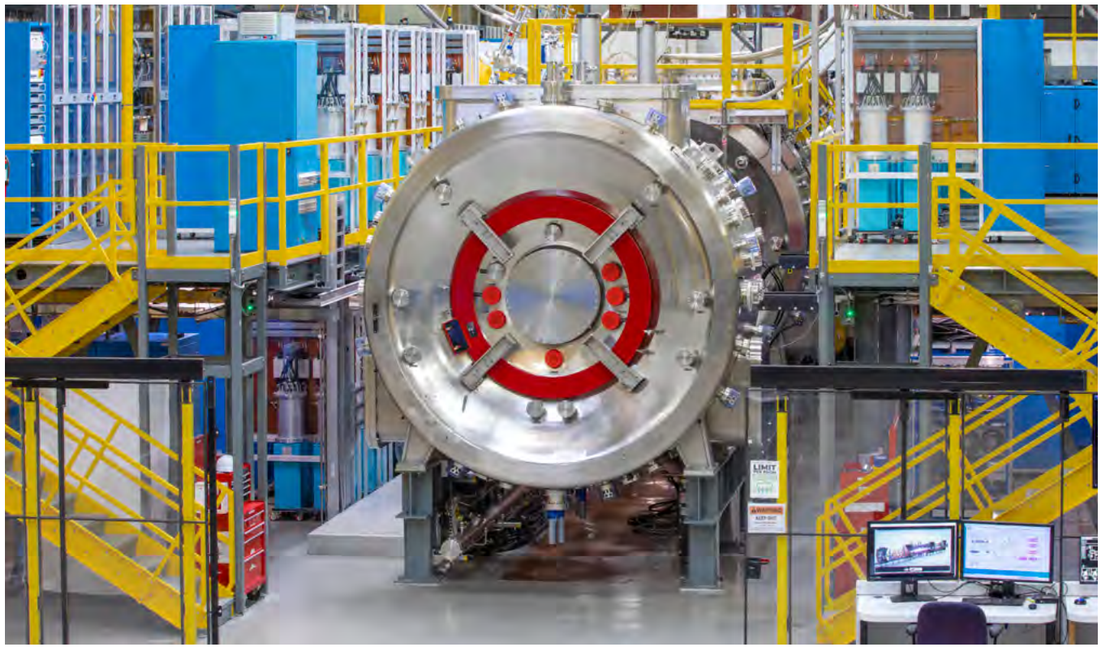
FIA MEMBER

tae

TAE TECHNOLOGIES

TAE Technologies (pronounced T-A-E) is developing safe, non-radioactive, cost-effective, commercial fusion energy capable of sustaining the planet for centuries. Through its unique approach to fusion, TAE has developed spinoff applications in life sciences, energy storage, electric mobility, and fast charging to create a complete clean energy ecosystem. Multidisciplinary and mission-driven by nature, TAE is leveraging proprietary science and engineering to create a bright future.

Location	Foothill Ranch, California, USA; Locations in UK, EU, and Switzerland
Contact Details	press@tae.com; pga@tae.com
Year founded	1998
Founder Names	Numerous founders
Primary target markets	Electricity generation
Total declared funding to date	>$1,200,000,000
Employees (incl. full time consultants)	>600
General approach	Magnetic confinement
Specific approach	Field-Reversed Configuration
Fuel Source	Pursuing p-B11; TAE configuration can also accommodate other fusion fuel cycles such as D-T, D-He3, and D-D
Planned energy capture approach	Heat capture and conventional thermal cycle and/or future direct energy conversion
Pilot plant timescale	2030s: Da Vinci device, prototype p-B11 / hydrogen-boron fusion power plant
Anticipated MWe of first commercial operating facility	350-500 MWe
Interim plants or facilities planned	Copernicus device will demonstrate the viability of TAE's concept at fusion-relevant conditions by operating with hydrogen fuel at the D-T breakeven operating point. For more device timeline, see https://tae.com/history
Milestones in past 12 months	– First-ever measurements of hydrogen-boron fusion in a magnetically confined fusion plasma in collaboration with Japan's National Institute for Fusion Science – Started construction of Copernicus facility
Recent company investments	– New fusion device construction and facility in CA – Launched TAE Power Solutions subsidiary – Acquired two UK power technologies companies – UK office expansion and battery testing facilities
Key collaborators/partners	Argonne National Laboratory, Chinese Academy of Science – Institute of Plasma Physics, General Atomics, Google, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Massachusetts Institute of Technology, National Institute for Fusion Science – Japan, Nihon University, Oak Ridge National Laboratory, Princeton Plasma Physics Laboratory, Swarthmore College, University of California – Irvine, University of California – Los Angeles, University of Pisa, University of Rochester, University of Texas at Austin, University of Wisconsin – Madison See Collaborators page on TAE.com for complete list https://tae.com/collaborators
Recent spin outs/patents/commercial innovations	– TAE Life Sciences: Targeted cancer treatment leveraging accelerator beams developed for TAE fusion began human trials. – TAE Power Solutions: Commercializing technologies for battery energy storage systems, e-mobility powertrains, off-grid/micro-grid, fast charging, second life of batteries and more. – ~1400 granted patents to date
Recent published papers	Nature Communications, February 2023: "First measurements of p11B fusion in a magnetically confined plasma" See Research Library on TAE.com for complete list https://tae.com/research-library



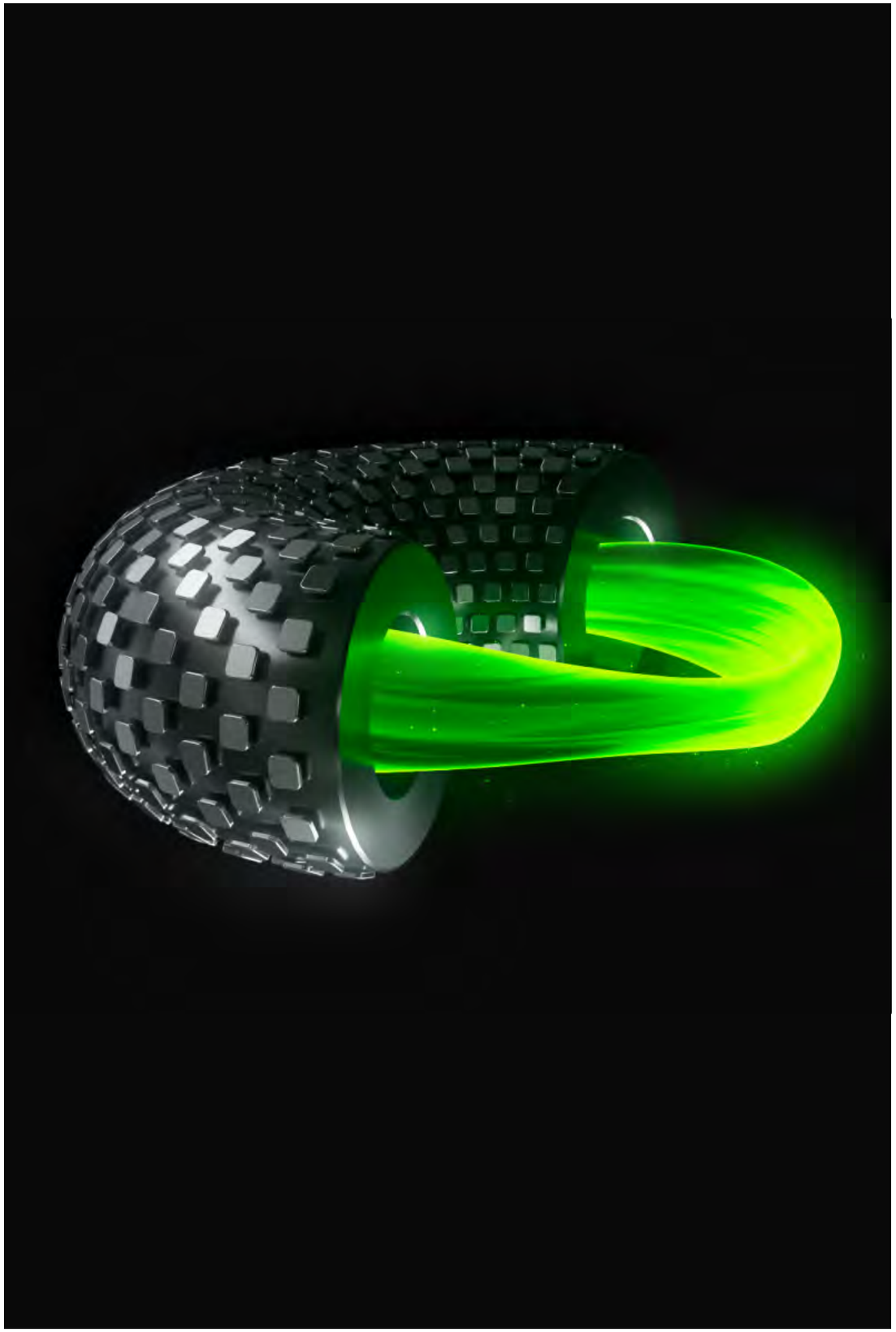
© TAE Technologies

THEA ENERGY

THEA ENERGY (FORMERLY PRINCETON STELLARATORS)

Thea Energy reinvented the stellarator, enabling systems to be simpler than previously thought possible. The Company's proprietary system architecture leverages arrays of planar coils to replace the complex and highly precise modular coils required in all other stellarators, allowing for accelerated deployment of fusion power plants.

Location	Princeton, New Jersey, USA
Contact Details	info@thea.energy
Year founded	2022
Founder Names	David Gates, Brian Berzin, Matt Miller
Primary target markets	Electricity generation, Medical
Total declared funding to date	$23,000,000
Employees (incl. full time consultants)	20
General approach	Magnetic confinement
Specific approach	Stellarator
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	Pilot plant in the 2030s.
Anticipated MWe of first commercial operating facility	>200 MWe
Interim plants or facilities planned	Steady-state neutron source stellarator system operation before 2030.
Milestones in past 12 months	Development of a new, proprietary stellarator architecture utilizing an array of smaller, simple, and more economical HTS planar coils. This redesign of the stellarator allows for an unprecedented degree of control and configurability with better confinement than ever before and allows for entire system sectors to be accessed for maintenance. Selected for a DOE Milestone-Based Fusion Development Program award.
Key collaborators/partners	Numerous collaborations with national labs, academic institutions, and industrial partners.



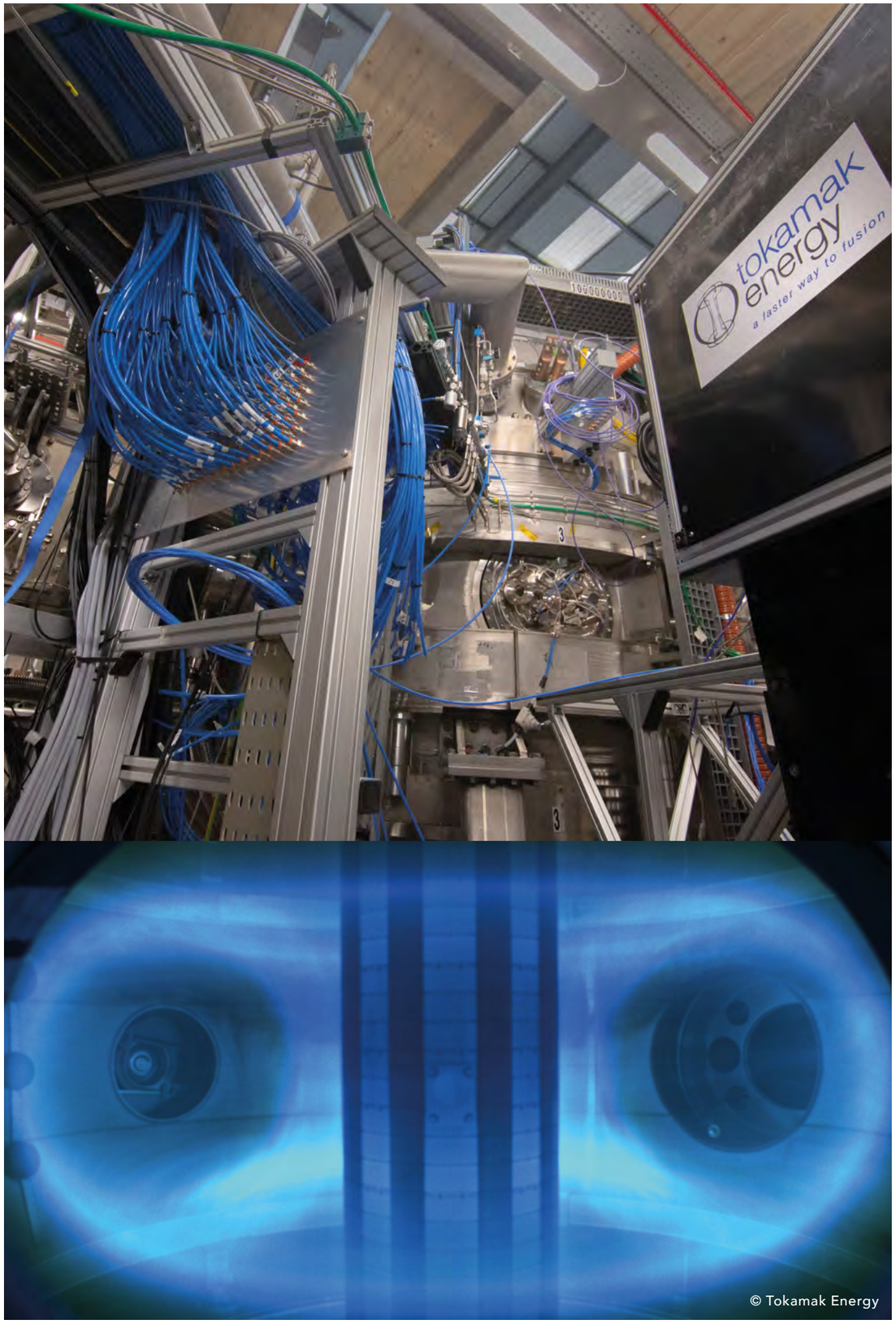
Tokamak Energy

FIA MEMBER

TOKAMAK ENERGY

Tokamak Energy is the only private fusion company to have more than 10 years' experience of designing, building and operating tokamaks. It is focussed on developing fusion pilot plants for the 2030s using spherical tokamaks and high temperature superconducting (HTS) magnets, as well as developing its HTS magnet technology for other industry applications.

Location	Oxford, UK; Bruceton Mills, West Virginia, US
Contact Details	Media Enquiries: media@tokamakenergy.com, Investor Relations: ir@tokamakenergy.com, Careers: careers@tokamakenergy.com
Year founded	2009
Founder Names	David Kingham, Mikhail Gryaznevich, Alan Sykes
Primary target markets	Electricity generation, Marine propulsion, Off-grid energy, Hydrogen/clean fuels, Industrial heat
Total declared funding to date	$250,000,000
Employees (incl. full time consultants)	255
General approach	Magnetic confinement
Specific approach	Spherical tokamak
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Pilot plant timescale	2033
Anticipated MWe of first commercial operating facility	500 MWe
Interim plants or facilities planned	ST80-HTS in 2027
Milestones in past 12 months	100 million degree Celsius plasma ion temperature and record triple product for a private company and for a spherical tokamak. Built a world-first set of new generation HTS magnets to be assembled and tested in fusion power plant-relevant scenarios.
Recent company investments	Major new HTS magnet system in spherical tokamak configuration; addition of Thompson scattering measurement system to ST40 - our world-leading high-field, compact, spherical tokamak.
Key collaborators/partners	Oak Ridge, Princeton, Los Alamos and Sandia National Labs; UKAEA; Superpower/Furukawa and General Atomics
Recent spin outs/patents/commercial innovations	Over 70 families of patents in total, including 35 families of patents covering all aspects of HTS magnet engineering including robust quench protection.
Recent published papers	Achievement of ion temperatures in excess of 100 million degrees Kelvin in the compact high-field spherical tokamak ST40 - https://iopscience.iop.org/article/10.1088/1741-4326/acbec8 This paper also includes our record triple product result.



© Tokamak Energy

TYPE ONE ENERGY GROUP

Type One Energy Group uses stellarator physics and engineering to bring its stellarator fusion power system to international energy markets. The globally-recognized team brings a strong track record of building stellarators and applies proven innovations in advanced manufacturing, modern computational physics and high-field superconducting magnets to optimize its stellarator for power production.

Location	Madison, Wisconsin; Boston, Massachusetts, USA
Contact Details	media@typeoneenergy.com
Year founded	2019
Founder Names	Randall Volberg, David Anderson, John Canik, Paul Harris, Chris Hegna
Primary target markets	Electricity generation, Hydrogen/clean fuels, Industrial heat
Total declared funding to date	$30,000,000
Employees (incl. full time consultants)	30
General approach	Magnetic confinement
Specific approach	Stellarator
Fuel Source	DT
Planned energy capture approach	Lithium neutron 'blanket'
Milestones in past 12 months	World's first HTS Stellarator Magnet
Pilot plant timescale	2033
Anticipated MWe of first commercial operating facility	500 MWe
Interim plants or facilities planned	Risk Retirement Platform - small scale stellarator incorporating HTS magnets, advanced optimization, and advanced manufacturing. Staging device prior to building Fusion Power Plant (FPP).
Milestones in past 12 months	Completed world's first HTS Stellarator Magnet under ARPA-E grant, which met all technical milestones.
Recent company investments	New facilities in Madison, WI and Boston, MA, acceptance into DOE Milestone-Based Fusion Development Program, long term collaboration agreements for fusion power plant development
Key collaborators/partners	MIT, CFS, ORNL, UW-Madison, LBNL, PPPL, and others
Recent published papers	Development of the first multi-turn non-planar REBCO stellarator coil using VIPER cable (2023)

XCIMER ENERGY INC.

Xcimer Energy is developing an inertial fusion energy system that will overcome long-standing obstacles to viable fusion power by integrating low-cost and high-energy excimer laser technology with the HYLIFE thick-liquid-wall chamber concept.

Location	Redwood City, California, USA
Contact Details	media@xcimer.energy
Year founded	2021
Founder names	Conner Galloway, Alexander Valys, Benjamin Wheeler
Primary target markets	Electricity generation
Total declared funding to date	$12,000,000
Employees (incl. full time consultants)	30
General approach	Inertial confinement
Specific approach	Laser-driven inertial confinement
Fuel Source	DT
Planned energy capture approach	Liquid lithium-salt waterfall
Pilot plant timescale	10
Anticipated MWe of first commercial operating facility	400
Interim plants or facilities planned	Prototype laser systems. Commercial breakeven target demonstration.
Key collaborators/partners	Laboratory for Laser Energetics, Naval Research Laboratory, LLNL, General Atomics, Westinghouse, LANL, ORNL, SRNL

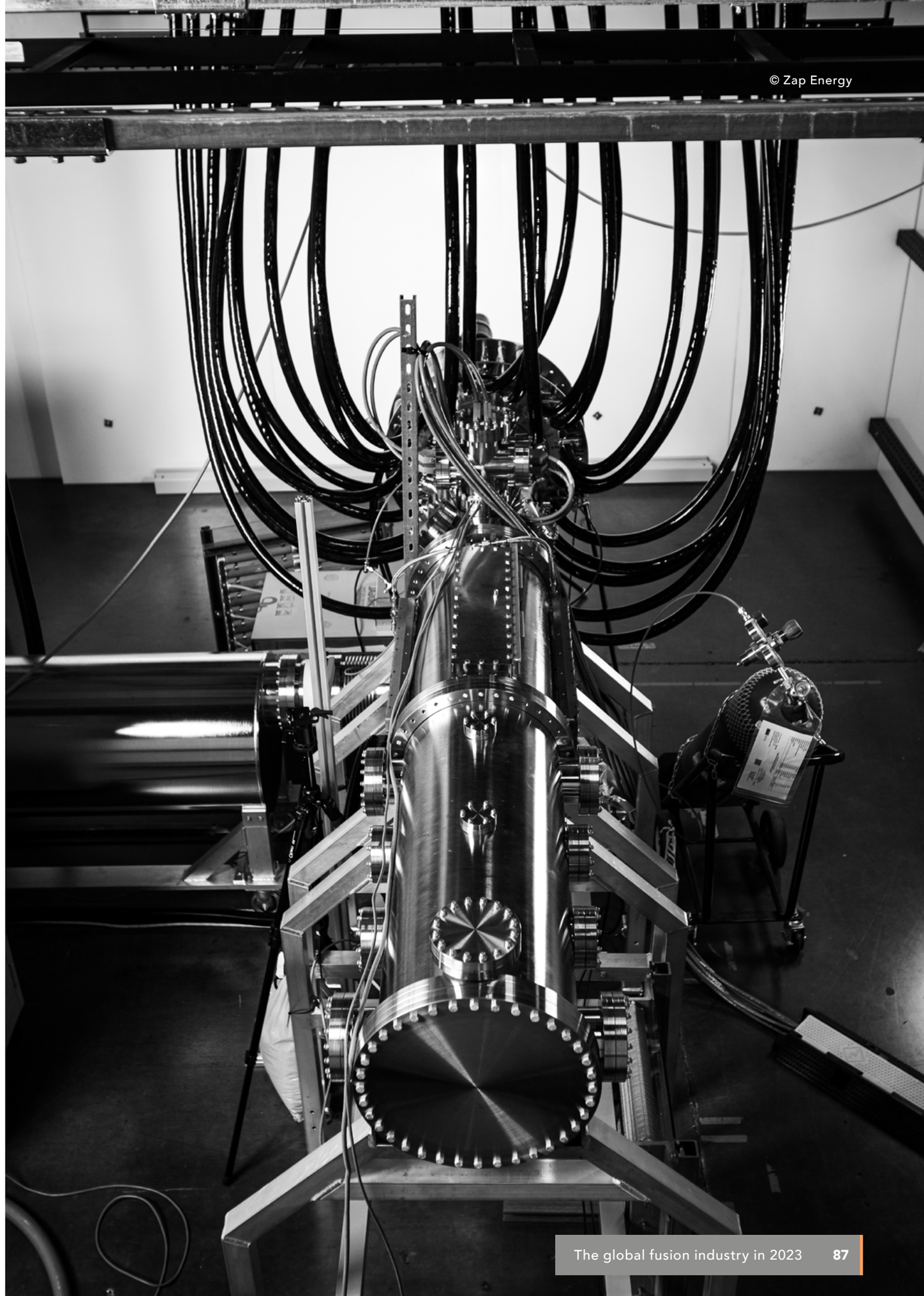
FIA MEMBER

ZAP ENERGY

ZAP ENERGY

Zap Energy is building a low-cost, compact and scalable fusion energy platform that confines and compresses plasma without magnetic coils or high-power lasers. Zap's quickly-advancing sheared-flow-stabilized Z-pinch technology provides compelling fusion economics and requires orders of magnitude less capital than conventional approaches.

Location	Everett & Mukilteo, Washington, USA
Contact Details	reachout@zap.energy
Year founded	2017
Founder Names	Benj Conway, Brian A. Nelson, Uri Shumlak
Primary target markets	Electricity generation, Industrial heat
Total declared funding to date	$208,000,000
Employees (incl. full time consultants)	140
General approach	Magnetic confinement
Specific approach	Z-pinch
Fuel Source	DT
Planned energy capture approach	Liquid metal with heat exchanger
Pilot plant timescale	Pilot plant siting feasibility study underway.
Recent company investments	Follow progress at zapenergy.com
Key collaborators/partners	University of Washington, Lawrence Livermore National Laboratory, UC Berkeley, Los Alamos National Laboratory, UC San Diego, University of Nevada, Reno, TransAlta
Anticipated MWe of first commercial operating facility	Each module is anticipated to be roughly 50 MWe, allowing scaling from small plants to GWe.
Recent published Papers	[1] "Fusion Gain and Triple Product for the Sheared-Flow-Stabilized Z Pinch," Fusion Science and Technology (2023) https://doi.org/10.1080/15361055.2023.2198049; [2] "Engineering Paradigms for Sheared-Flow-Stabilized Z-Pinch Fusion Energy," Fusion Science and Technology (2023) https://doi.org/10.1080/15361055.2023.2209131 [3] Computationally efficient high-fidelity plasma simulations by coupling multi-species kinetic and multi-fluid models on decomposed domains, Journal of Computational Physics (2023) https://doi.org/10.1016/j.jcp.2023.112073; [4] Probing local electron temperature and density inside a sheared flow stabilized Z-pinch using portable optical Thomson scattering, Review of Scientific Instruments (2023) https://aip.scitation.org/doi/10.1063/5.0135265; For further publications, see zapenergy.com/research



FUSION
INDUSTRY ASSOCIATION

Fusion Industry Association
800 Maine Ave SW
Suite 223
Washington, DC 20024
United States

twitter.com/Fusion_Industry
www.linkedin.com/company/fusion-industry-association
www.youtube.com/c/FusionIndustryAssociation
anchor.fm/fusionindustry