Last year, we started our report by saying “It is an exciting time for fusion energy” – and little did we know how transformative the year to come would be. When the history books are written about fusion energy, the last 12 months will be seen as the turning point when it became clear that fusion would move out of the laboratories and into the marketplace.

For just a few examples, we saw a controlled “burning plasma” for the first time at the National Ignition Facility in California, record amounts of energy produced from the Joint European Torus in Oxford, and record lengths of high-temperature plasma confinement at KSTAR in South Korea and at EAST in China. Not to be outdone, privately funded fusion companies in the FIA reached important milestones of their own: Commonwealth Fusion Systems in Massachusetts demonstrated the world’s strongest magnet, while Helion in Washington and Tokamak Energy in the UK each reached milestone plasma temperatures of above 100 million degrees, and General Fusion in Canada proved their ability to precisely compress a plasma.

Now, with those milestones achieved, private investment is coming in, allowing the fusion industry to build the proof-of-concept devices that will show fusion energy can work. As our survey shows, private industry has secured over $2.8 billion in new private investment since our last survey a year ago, bringing total private investment to over $4.7 billion. This funding will allow fusion companies to push toward their “Kitty Hawk moment” in the coming years. From there, companies will rapidly build the pilot plants that will prove fusion energy is ready for the marketplace.

As fusion transitions from the lab to commercialization, private companies need governments to become a real partner in this effort. We must not see a “competition” between publicly funded and privately funded fusion approaches; instead, we must build real partnerships. As the private sector builds the power plants, governments will need to build the infrastructure and train the workforce that enable the fusion energy revolution. In a virtuous cycle, greater investment and partnerships will “crowd in” more private fusion investment and show the value of the way forward.

In March of 2022, I and many FIA members went to the White House for a summit, hosted by the US Department of Energy and the Office of Science and Technology Policy to plan a “Bold Decadal Vision for Commercial Fusion Energy.” The plan, being put together now, is to build, in 10 years, multiple fusion pilot plants of different sizes, approaches, and fuels operating in new fusion technology hubs around the country. This plan will also need funding and political support, but it shows the growing interest in fusion. Importantly as well, to support safe deployment, industry is working with regulators around the world to ensure that fusion energy is safe and appropriately regulated.

Outside of our work on fusion, we’ve seen too many reminders in the last year of why fusion investment is so important. The news about climate change continues to show that countries are not meeting their pledged emissions reductions goals, while impacts like droughts, heat waves and extreme storms get worse.
In the geopolitical realm, Russia’s invasion of Ukraine and the unified Western response is partially a story about energy. Putin would not have been able to finance his war machine, nor dared invade Ukraine, had Russia not had vast hydrocarbon deposits. When fusion is widely available, these “energy weapons” will not be nearly as powerful against peaceful nations.

As we respond to these crises of today, fusion investments can help secure the peace for the long term. If we make the required investments now, fusion energy should provide the basis for prosperity, safety, and security.

The state of the global fusion industry in 2022

In this survey, fusion companies declared over $4.7bn of private funding to date, plus an additional $1.17 million in grants and other funding from governments, more than doubling the industries entire historic investment in a single year. These included notable investments including a massive $1.8bn investment into Commonwealth Fusion Systems, $500m into Helion Energy and several important ones over $100m.

As the charts presented below show, the vast majority of companies are focused primarily on energy generation, however most reported at least two other potential markets for their technologies, with space and marine propulsion being the most common, as well as widespread interest in using fusion energy to produce not just electricity to the grid but as a way to produce hydrogen, clean fuels or off grid energy. Many companies are flexible and pursuing multiple markets.

Expectations remain consistent with last year with the vast majority of companies predicting fusion will first power the grid at some point in the 2030s, although a more detailed breakdown of this question this year shows a leaning towards the first half of the decade.

For all the progress, one area that clearly still needs work is in promoting a more diverse workforce. Self-reporting of data remains patchy, but women and minority groups remain underrepresented in fusion, a problem that exists throughout science and engineering industries. In this year’s report, we note a small increase in the percentage of female employees at fusion companies from 21.8% to 23.8%, and we are excited to see new programs like “Women in Fusion” that will increase opportunities in this growing industry. This is important because a diverse workforce both ensures that the benefits of fusion are widely shared and because a workforce that reflects broader society brings real benefits in decision making to the industry.

We would like to thank all the companies involved for talking about their businesses and scientific progress to help us build this picture of the fusion industry. We hope it will become a useful resource for both the fusion community and those outside the fusion sector wishing to know more.

About the report

This is the second 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 second report, we’ve reached five fusion companies that we did not know about or could not contact when we did the last report, as well as eight companies that have come on the scene in the last year. There are still certainly some companies that we have missed either because we do not yet know about them, or because they declined to participate, though we believe we have captured all those at an advanced stage. 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 2022. 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. We hope to build a “supply chain” report that reflect the status of these companies soon.

About the 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.

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

1. Funding for Fusion Companies

**Total**

$4,860,314,000 ($4.8bn+)

**Private**

$4,742,819,000 ($4.7bn+)

$117,495,000 ($117m+)

2. Change since 2021 Survey

2.83bn declared in new funding since last survey

$2.03bn total secured at time of 2021 survey

139% increase in funding since last year’s report

33 responses vs 23 in 2021

8 companies founded or emerged from stealth mode

5 new respondents completed the survey (and two dropped out)

3. Notable Investments since the Last Survey

- **$1.8bn** Commonwealth Fusion Systems
- **$500m** Helion Energy

4. Companies with $200m Investment or More

- TAE Technologies ($1bn+)
- General Fusion
- Tokamak Energy
- Commonwealth Fusion Systems ($2bn+)
- ENN
- Helion Energy
- Zap Energy

5. Location

By primary HQ

- Canada 1
- Australia 1
- China 1
- Japan 1
- Germany 1
- Italy 1
- France 1
- USA 21
- UK 3
- France 2
- Israel 1

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

2 The declared in funding in last year's report was $1.87bn. This year's report includes additional survey participants with pre-2021 funding that was not reported last year. This figure is adjusted to include this additional data.
6. TARGET MARKETS

Primary Markets (Respondents could select multiple):

- Electricity generation: 28
- Space propulsion: 4
- Marine propulsion: 2
- Medical: 3
- Off-grid energy: 9
- Hydrogen and/or clean fuels: 9
- Industrial heat: 7

Potential/spin-off markets:

- Electricity generation: 4
- Space propulsion: 17
- Marine propulsion: 12
- Medical: 9
- Off-grid energy: 10
- Hydrogen and/or clean fuels: 12
- Industrial heat: 14

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.

By role (based on 24/33 responses):

- Scientists: 26%
- Engineers: 25%
- Other: 23.8%
- Male: 76.1%
- Female: 0.1%
- Other: 25%

8. SELECTED* INVESTORS IN FUSION

Addition
Art Samberg
Bezos Expeditions
Bill Gates
Braavos Capital
Braemar Energy Ventures
Breakthrough Energy Ventures
Business Development Bank of Canada (BDC)
Capricorn Investment Group (Jeff Skoll)
Cenovus Energy
Charles Schwab
Chevron Technology Ventures
Chrysalix Venture Capital
Coatue
David Harding (CEO of Winton Group)
DCVC
DFJ Growth
Dr Hans-Peter Wild (Owner of Capri Sun)
Dustin Moskovitz
Emerson Collective
Energy Impact Partners
Eni
Equinor
Fine Structure Ventures
Footprint Coalition
Future Ventures
GA Capital
GIC
Google
Grantham Foundation for the Environment
Hostplus
IP Group
Jameel Investment Management Company (JIMCO)
The Engine
Tiger Global Management
TIME Ventures (Marc Benioff)
Tobias Lüke
Valor Equity Partners
Venrock
Vulcan Capital
Wellcome Trust
Y Combinator

*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.
9. Approach

General approach
- 15 Magnetic confinement
- 8 Inertial confinement
- 7 Magneto-inertial
- 2 Electrostatic Hybrid
- 1 Muon-catalyzed fusion

Specific approach
- 4 Field Reversed Configuration
- 4 Stellarator
- 3 Tokamak/Spherical Tokamak
- 2 Z-pinch
- 1 Dense Plasma Focus
- 1 Epicyclotron: a hybrid beam background approach
- 1 Hypervelocity Gradient Field Fusion
- 1 Laser-driven inertial confinement
- 1 Magnetic mirror
- 1 Magnetized target fusion
- 1 Modified Stellarator
- 1 Muon-catalyzed fusion with high density fuel
- 1 Non-thermal laser fusion
- 1 Orbitron (Electrostatic ion orbiting a cathode with magnetron (ExB) electron confinement)
- 1 Oscillating fusion-fizzle cycles with direct EMF extraction
- 1 Plasma Jet driven Magneto Inertial Fusion
- 1 Plectonemic reconnection
- 1 Poloidal magnetic confinement, e.g. Levitron, LDX, Intrap
- 1 Shock-driven inertial confinement
- 1 Spheromak
- 1 Spindle cusp, superconducting shielded-grid

10. Fuel Source

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD</td>
<td>2</td>
</tr>
<tr>
<td>DD, pB11</td>
<td>1</td>
</tr>
<tr>
<td>DHe3</td>
<td>2</td>
</tr>
<tr>
<td>DT</td>
<td>22</td>
</tr>
<tr>
<td>pB11</td>
<td>5</td>
</tr>
<tr>
<td>Proton-Lithium</td>
<td>1</td>
</tr>
</tbody>
</table>

11. Predictions/Challenges

When will the first fusion plant deliver electricity to the grid? (27 responses)

- Before 2025: 1
- 2025-2030: 3
- 2031-2035: 14
- 2036-2040: 7
- 2041-2045: 2

When will the first fusion plant demonstrate a low enough cost/high enough efficiency (Q) to be considered commercially viable? (25 responses)

- Before 2025: 1
- 2025-2030: 2
- 2031-2035: 6
- 2036-2040: 3
- 2041-2045: 1
- After 2050: 1
12. Fusion companies founded in the last 30 years

13. Total number of private fusion companies by year
PROFILES OF TODAY’S FUSION PLAYERS

FUEL SOURCE KEY

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td>deuterium - tritium</td>
</tr>
<tr>
<td>DD</td>
<td>deuterium - deuterium</td>
</tr>
<tr>
<td>pB11</td>
<td>proton - boron</td>
</tr>
<tr>
<td>DHe3</td>
<td>deuterium - helium3</td>
</tr>
</tbody>
</table>
Avalanche Energy is developing a 5kWe fusion power pack called the "Orbitron" in a form-factor the size of a lunch pail. The compact size is a key enabler of scaling for applications including micro-grids, long haul trucking, maritime shipping, aviation and space power and propulsion.

<table>
<thead>
<tr>
<th>Location</th>
<th>Tukwila, Washington, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:reachout@avalanche.energy">reachout@avalanche.energy</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2018</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Robin Langtry, Brian Riordan</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Space propulsion and power, Marine propulsion, Aviation, Off-grid energy, Hydrogen/synthetic fuels</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$5,125,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>14</td>
</tr>
<tr>
<td>General approach</td>
<td>Hybrid: Inertial electrostatic ion with magnetic electron</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Orbitron (Electrostatic ion orbiting a cathode with magnetron (ExB) electron confinement)</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron &quot;blanket&quot;</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>From proof-of-concept simulations to prototype and first fusion neutrons in 9 months.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>Q4/2025 delivery of first prototype to DIU/DoD for qualification testing. Orbital demonstration in 2027.</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>0.005 MWe</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>DoD: Defense Innovation Unit (DIU)</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>1st Patent (Sept. 2020)</td>
</tr>
</tbody>
</table>
## COMMONWEALTH FUSION SYSTEMS

Commonwealth Fusion Systems (CFS) is aiming to develop the fastest, lowest cost path to commercial fusion energy, using high temperature superconductors to build small, low-cost fusion power plants.

<table>
<thead>
<tr>
<th>Location</th>
<th>Cambridge, Massachusetts, (relocating to Devens, Massachusetts in late 2022), USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:info@cfs.energy">info@cfs.energy</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2018</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Bob Mumgaard, Dan Brunner, Brandon Sorbom, Dennis Whyte, Martin Greenwald, and Zach Harwig</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$2,000,000,000+ ($2bn)</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>300+</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Tokamak</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron 'blanket'</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>December 2021: Raised over $1.8 billion in Series B funding, including capital to construct, commission and operate SPARC, the world’s first commercially relevant net energy fusion machine. May 2022: MIT and CFS expanded research collaboration under a new 5-year agreement. Construction progress: nearing completion of construction of high temperature superconducting magnet factory and substantial progress on SPARC building in Devens, MA.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2025: SPARC achieves commercially relevant net energy from fusion. Early 2030s: First fusion power plant, ARC, completed.</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>More than 200 MWe</td>
</tr>
</tbody>
</table>

**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; 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**

2. Fiber optic quench detection for large-scale HTS magnets demonstrated on VIPER cable during high-fidelity testing at the SULTAN facility. Superconductor Science and Technology 34 035027 (2021)
3. Overview of the SPARC physics basis towards the exploration of burning-plasma regimes in high-field, compact tokomaks. Nucl. Fusion 62 042003 (2022)
COMPACT FUSION SYSTEMS, INC.
Developing a fusion approach based on compression of a field reversed configuration by implosion of a liquid metal cylinder is stabilized by rotation and free-piston drive, avoiding instability and permitting safe reversal after peak compression.

<table>
<thead>
<tr>
<th>Location</th>
<th>Santa Fe, New Mexico, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:rmillerrzzz@outlook.com">rmillerrzzz@outlook.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2018</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Ronald Miller, Peter Turchi, Simon Woodruff</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>General approach</td>
<td>Magneto-inertial</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Field Reversed Configuration</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Liquid metal with heat exchanger</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Conceptual design with advanced fuels</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>100 MWe</td>
</tr>
</tbody>
</table>

CROSSFIELD FUSION LTD
Crossfield Fusion has been developing a novel compact fusion reactor targeting carbon free heat and power generation. The company adopted a new approach to building fusion reactors based on patented technology called the Epicyclotron.

<table>
<thead>
<tr>
<th>Location</th>
<th>London, UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:enquires@crossfieldfusion.com">enquires@crossfieldfusion.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2019</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Chris Macdonald-Bradley, James Mckenzie</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
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<tr>
<td>Total declared funding to date</td>
<td>$950,000</td>
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<tr>
<td>Employees (incl. full time consultants)</td>
<td>1</td>
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<tr>
<td>General approach</td>
<td>Inertial confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Epicyclotron a hybrid beam background approach</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>In October 2021 the company determined epicyclotron would not scale up, now exploring the use of this technology the developed in hydrogen isotope separation as part of the fusion fuel cycle.</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>Hydrogen isotope separation as part of the fusion fuel cycle</td>
</tr>
</tbody>
</table>
CTFUSION, INC.

CTFusion is developing the Dynomak approach to magnetic fusion energy that uses spheromak magnetic confinement and imposed-dynamo current drive (IDCD). It aims to enable commercially viable fusion energy for the generation of heat and electricity.

**Location**
Seattle, Washington, USA

**Contact Details**
admin@ctfusion.net

**Year founded**
2015

**Founder Names**
Derek Sutherland, Chris Ajemian, Scott Brennan, Kyle Morgan, and Aaron Hossack

**Primary target markets**
Energy generation

**Total declared funding to date**
$23,000,000

**Employees (incl. full time consultants)**
10

**General approach**
Magnetic confinement

**Specific approach**
Spheromak

**Fuel Source**
DT

**Planned energy capture approach**
Lithium neutron ‘blanket’

**Milestones in past 12 months**
Demonstrated reactor-relevant power injection with P > 20 MW, toroidal currents Ip > 100 kA, and injector voltages V > 700 V. Demonstration formation and sustainment of spheromaks with a helicity injection manifold for the first time, de-risking the design point for the next scaled-up prototype.

**Pilot plant timescale**
Early 2030s

**Anticipated MWe of first commercial operating facility**
75-125 MWe

**Key collaborators/partners**
U.S. DOE (ARPA-E), U.S. DOE Office of Fusion Energy Science (OFES), University of Washington-Seattle, and commercial players we are not at liberty to disclose quite yet.

**Recent published Papers**
1. High-speed feedback control of an oscillating magnetic helicity injector using a graphics processing unit, AIP Review of Scientific Instruments
https://doi.org/10.1063/5.0044805
2. Driven resonant current amplification in self-organized plasma configurations with uniform \( \lambda \) and plasma pressure confinement, AIP Physics of Plasmas
https://doi.org/10.1063/5.0025959
3. Effect of injected flux and current temporal phasing on self-organization in the HIT-Si3 experiment, AIP Physics of Plasmas
https://doi.org/10.1063/5.0090665

DEUTELIO

Deutelio aims to achieve nuclear fusion by magnetic confinement with the Polomac configuration using the deuterium-deuterium reaction. It hopes to build a small prototype to validate the concept within three years, designing the first nuclear reactor in five years and achieving 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**
$534,500

**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, LDX, Intrap

**Fuel Source**
DD

**Planned energy capture approach**
Liquid metal with heat exchanger

**Milestones in past 12 months**
Technical discussion with EU key scientists in magnetic fusion research
Detailed design of a small prototype working with 0.15 m3 of H at 0.25 T expected to reach 1 KeV. It is envisaged to tune the magnetic tunnels and confirm their efficiency.

**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 first commercial operating facility**
30 MWe
### 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. We use a supercritical dense liquid metal fuel to create an ultra-low cost (<$5/MWh) direct-to-electricity scalable aneutronic fusion power generator.

**Location**: Broomfield, Colorado, USA  
**Contact Details**: info@electricfusionystems.com  
**Year founded**: 2020  
**Founder Names**: Ken E. Kopp and Ryan S. Wood  
**Primary target markets**: Electricity generation, Space propulsion, Off-grid energy, Small portable transportation 1-50 kW  
**Total declared funding to date**: $350,000  
**Employees (incl. full time consultants)**: 5  
**General approach**: Pulsed high density aneutronic fusion  
**Specific approach**: Oscillating fusion-fizzle cycles with direct EMF extraction  
**Fuel Source**: Proton-Lithium  
**Planned energy capture approach**: Direct electricity (energy) capture and conversion  
**Pilot plant timescale**: 2023  
**Anticipated MWe of first commercial operating facility**: 10 kilowatts to 10 megawatts in depending on number of cartridges and modules.  
**Key collaborators/partners**: Voss Scientific  
**Spin outs/patents/innovations**: Aneutronic Fusion Plasma Reactor and Electric Power Generator (Published May 2022)

### ENN

In 2018, the ENN Fusion Technology R&D Center was established with an aim to deliver clean commercial fusion electricity and heat to customers and radically improve its energy supply network. It is part of the ENN Science and Technology Development Co., Ltd, which is dedicated to addressing humanity’s energy challenges in a sustainable, reliable and economic manner.

**Location**: Langfang, China  
**Contact Details**: qixudong@enn.cn; +86-316-2597072  
**Year founded**: ENN Science and Technology Development Co., Ltd founded in 2006  
**Founder Names**: Yusuo WANG  
**Primary target markets**: Electricity generation, Industrial heat  
**Total declared funding to date**: $200,000,000  
**Employees (incl. full time consultants)**: 90 (2021 figures)  
**General approach**: Magnetic confinement  
**Specific approach**: Spherical tokamak  
**Fuel Source**: pB11  
**Pilot plant timescale**: 15 years  
**Key collaborators/partners**: Peking University, University of Tokyo, Southwestern Institute of Physics  
**Recent published Papers**:  
4. Experimental study of the characteristics of energetic electrons outside LCFS in EXL-50 spherical torus, Plasma Physics and Controlled Fusion, 2022; https://doi.org/10.1088/1361-6587/ac5a08
EX-Fusion aims to build and power the first laser-powered commercial nuclear fusion reactor.

**Location**: Osaka, Japan  
**Contact Details**: kazuki_matsuo@ex-fusion.com  
**Year founded**: 2021  
**Founder Names**: Kazuki Matsuo, Yoshitaka Mori, Shinsuke Fujioka  
**Primary target markets**: Electricity generation, Off-grid energy, Hydrogen/clean fuels  
**Total declared funding to date**: $1,100,000  
**Employees (incl. full time consultants)**: 8  
**General approach**: Inertial confinement  
**Specific approach**: Laser-driven inertial confinement  
**Fuel Source**: DT  
**Planned energy capture approach**: Lithium neutron "blanket"  
**Pilot plant timescale**: Late 2030s  

**Recent published Papers**

**FIRST LIGHT FUSION**

Inspired by the only natural example of inertial confinement on Earth, First Light Fusion is developing a practical pathway to fusion energy using the simplest machine possible.

<table>
<thead>
<tr>
<th><strong>Location</strong></th>
<th>Oxfordshire, UK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contact Details</strong></td>
<td><a href="mailto:enquiries@firstlightfusion.com">enquiries@firstlightfusion.com</a></td>
</tr>
<tr>
<td><strong>Year founded</strong></td>
<td>2011</td>
</tr>
<tr>
<td><strong>Founder Names</strong></td>
<td>Dr Nicholas Hawker, Prof Yiannis Ventikos</td>
</tr>
<tr>
<td><strong>Primary target markets</strong></td>
<td>Electricity generation</td>
</tr>
<tr>
<td><strong>Total declared funding to date</strong></td>
<td>$97,813,500</td>
</tr>
<tr>
<td><strong>Employees (incl. full time consultants)</strong></td>
<td>70</td>
</tr>
<tr>
<td><strong>General approach</strong></td>
<td>Inertial confinement</td>
</tr>
<tr>
<td><strong>Specific approach</strong></td>
<td>Shock-driven inertial confinement</td>
</tr>
<tr>
<td><strong>Fuel Source</strong></td>
<td>DT</td>
</tr>
<tr>
<td><strong>Planned energy capture approach</strong></td>
<td>Liquid metal with heat exchanger</td>
</tr>
<tr>
<td><strong>Milestones in past 12 months</strong></td>
<td>First Light Fusion announced the achievement of fusion, proving their unique target technology, in April 2022. The result has been independently validated by the UK Atomic Energy Authority (UKAEA).</td>
</tr>
<tr>
<td><strong>Anticipated MWe of first commercial operating facility</strong></td>
<td>150 MWe</td>
</tr>
<tr>
<td><strong>Recent published Papers</strong></td>
<td>A preliminary assessment of the sensitivity of uniaxially driven fusion targets to flux-limited thermal conduction modeling</td>
</tr>
<tr>
<td><strong>Key collaborators/partners</strong></td>
<td>IDOM, UKAEA</td>
</tr>
</tbody>
</table>
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**
Todd Ditmire, Thomas Forner, Markus Roth, Anika Stein

**Primary target markets**
Electricity generation

**Total declared funding to date**
$15,000,000

**Employees (incl. full time consultants)**
50

**General approach**
Inertial confinement

**Specific approach**
Laser-driven inertial confinement

**Fuel Source**
DT

**Planned energy capture approach**
Lithium neutron "blanket"

**Milestones in past 12 months**

**Pilot plant timescale**
2035

**Anticipated MWe of first commercial operating facility**
800 MWe

**Key collaborators/partners**
Department of Energy, University of Texas, Technische Universität Darmstadt, Laboratory for Laser Energetics Rochester/NY, Extreme Light Infrastructure Prague

**Spin outs/patents/innovations**
Laser Driven Radiation Source, novel ion beam detector

**Recent published Papers**
**GENERAL FUSION**

General Fusion pursues a fast, efficient, and collaborative path to practical fusion power. The company is completing an aggressive development plan to deliver economical carbon-free fusion energy with its proprietary Magnetized Target Fusion technology by the early 2030s.

<table>
<thead>
<tr>
<th>Locations</th>
<th>Vancouver, Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>London, U.K.</td>
</tr>
<tr>
<td></td>
<td>Oak Ridge, Tennessee, U.S.A.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contact Details</th>
<th><a href="mailto:info@generalfusion.com">info@generalfusion.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year founded</td>
<td>2002</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Michel Laberge</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$300 million+</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>207</td>
</tr>
<tr>
<td>General approach</td>
<td>Magneto-inertial</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Magnetized Target Fusion</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Liquid metal with heat exchanger</td>
</tr>
</tbody>
</table>

**Milestones in past 12 months**

- Successfully demonstrated key elements of proprietary plasma compression technology
- Began site preparations for Fusion Demonstration Plant at the UKAEA Culham Centre for Fusion Energy
- Opened new headquarters for new demonstration prototypes and plan to quadruple workforce over the next few years
- Closed oversubscribed $130M financing
- Formed Market Development Advisory Committee to guide commercial fusion power plant development

**Pilot plant timescale**

*Underway*: Fusion Demonstration Plant at UKAEA’s Culham Centre for Fusion Energy

**Early 2030s**: First commercial fusion power plant completed

**Anticipated MWe of first commercial operating facility**

Approx. 230 MWe from two machines operating in tandem

<table>
<thead>
<tr>
<th>Key collaborators/partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected partners and suppliers: AL_A, ARUP, Canadian Nuclear Laboratories, Hatch Ltd, McGill University, Oak Ridge National Laboratory, Princeton Plasma Physics Laboratory, Sheffield Forgemasters, Turner &amp; Townsend, UKAEA Culham Centre for Fusion Energy, University of Illinois</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spin outs/patents/innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 patents and patents pending</td>
</tr>
</tbody>
</table>
**HB11 ENERGY**

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

<table>
<thead>
<tr>
<th>Location</th>
<th>Sydney, Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:contact@hb11.energy">contact@hb11.energy</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2017</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Heinrich Hora, Warren McKenzie, Jan Kirchhoff, Lukasz Gadowski</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, Hydrogen/clean fuels, Industrial heat</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>5</td>
</tr>
<tr>
<td>General approach</td>
<td>Inertial confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Non-thermal laser fusion</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>pB11</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Direct energy conversion</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Several Experiments in the Pipeline, Progress on code development for pB11 Fuel interaction, Part of two different Australian Trailblazer Universities Programs</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2030s</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>300-500 MWe</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>The University of Adelaide, Deakin University, University of Bordeaux, Voss Scientific, Woodruff Scientific</td>
</tr>
</tbody>
</table>

**HELICAL FUSION**

Helical Fusion aims to realize the world’s first fusion reactor with the helical (heliotron) magnetic configuration.

<table>
<thead>
<tr>
<th>Location</th>
<th>Tokyo, Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:contact@helicalfusion.com">contact@helicalfusion.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2021</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Junichi Miyazawa, Takaya Taguchi, Nagato Yanagi, Takuya Goto</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, Hydrogen/clean fuels, Industrial heat</td>
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<td>Total declared funding to date</td>
<td>$550,000</td>
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<td>Employees (incl. full time consultants)</td>
<td>5</td>
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<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Stellarator</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron 'blanket'</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Establishment of the company.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>Early 2040’s (pilot plant proving commercial viability)</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>100 MWe</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>National Institute for Fusion Science</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>High-temperature superconducting magnet, liquid metal application</td>
</tr>
</tbody>
</table>

© Helical Fusion
**HELCITYSPACE CORP.**
HelicitySpace Corp. develops in-space fusion propulsion engines for deep space travel.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pasadena, California, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:info@helicityspace.com">info@helicityspace.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2018</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Dr. Setthivoine You, Dr. Stephane Lintner, Marta Calvo</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Space propulsion</td>
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<tr>
<td>Total declared funding to date</td>
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<td>Employees (incl. full time consultants)</td>
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<tr>
<td>General approach</td>
<td>Magneto-inertial</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Plectonemic reconnection</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DD</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Thrust</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Prototype assembly</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>Protolight in 2032</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>Los Alamos National Laboratory, Caltech, UMBC, DOE, Limitless Space Institute</td>
</tr>
</tbody>
</table>

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**HELION ENERGY**
Helion Energy, Inc. is developing a pulsed non-ignition fusion technology to produce fusion power using deuterium and helium-3.

<table>
<thead>
<tr>
<th>Location</th>
<th>Everett, Washington, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:inquiries@helionenergy.com">inquiries@helionenergy.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2013</td>
</tr>
<tr>
<td>Founder Names</td>
<td>David Kirtley, Chris Pihl, George Votroubek, John Slough</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$577,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>90</td>
</tr>
<tr>
<td>General approach</td>
<td>Magneto-inertial</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Field Reversed Configuration</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DHe3</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Direct energy conversion</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>- Announced reaching 9 keV in Trenta, Helion’s 6th fusion prototype</td>
</tr>
<tr>
<td></td>
<td>- Raised $500 million (sufficient to reach commercialization)</td>
</tr>
<tr>
<td></td>
<td>- Moved to new headquarters in Everett, WA</td>
</tr>
<tr>
<td></td>
<td>- Completed construction of the facility to house Helion’s 7th fusion prototype, Polaris</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>Polaris net electricity demonstration – 2024</td>
</tr>
<tr>
<td></td>
<td>Pilot plant – end of decade</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>50 MWe per generator</td>
</tr>
</tbody>
</table>
HORNE TECHNOLOGIES
Horne Technologies is a commercial fusion company targeting affordable advancement of fusion technology for near-term energy and neutron production. Horne Technologies’ hybrid approach enables rapid low-cost iteration with fusion-capable, continuously operating devices.

Location | Longmont, Colorado, USA
Contact Details | hornetech@protonmail.com
Year founded | 2008
Founder Names | Tanner Horne
Primary target markets | Electricity generation
Total declared funding to date | $1,650,000
Employees (incl. full time consultants) | 3
General approach | Hybrid magnetic and electrostatic confinement
Specific approach | Spindle cusp, superconducting shielded-grid IEC
Fuel Source | DD, pB11
Milestones in past 12 months | Series A financing. Construction of Gen-II device. All systems operational for fusion temperatures. Continuing development of full power device utilizing 5T magnets and 100 keV temperature.
Pilot plant timescale | 3-5 years
Anticipated MWe of first commercial operating facility | Less than 1 MWe

HYPERJET FUSION CORPORATION
A company developing Plasma Jet driven Magneto Inertial Fusion

Location | Chantilly, Virginia USA
Contact Details | cfaranetta@hyperjetfusion.com
Year founded | 2017
Founder Names | Doug Witherspoon
Primary target markets | Electricity generation
Total declared funding to date | $20,000,000
Employees (incl. full time consultants) | 7
General approach | Magneto-Inertial Fusion
Specific approach | Plasma Jet Driven Magneto Inertial Fusion (PJMIF)
Fuel Source | DT
Planned energy capture approach | Lithium neutron ‘blanket’
Milestones in past 12 months | Development and demonstration of magnetized fuel target plasma gun
Pilot plant timescale | TBD
Key collaborators/partners | Los Alamos National Laboratory
Spin outs/patents/innovations | High-temperature superconducting magnet, liquid metal application
### 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Middlesex, New Jersey, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:fusionfan@lppfusion.com">fusionfan@lppfusion.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2003</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Eric J. Lerner</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, Space propulsion, Marine propulsion, Off-grid energy, Industrial heat</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$9,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>3</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Dense Plasma Focus</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>pB11</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Direct energy conversion</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>World record for fusion plasma purity. Installed new switches.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2025</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>5 MWe</td>
</tr>
</tbody>
</table>

### MAGNETO-INERTIAL FUSION TECHNOLOGY INC. (MIFTI)

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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Tustin, California, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:contact@miftec.com">contact@miftec.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2009</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Hafiz Rahman, Jerry Simmons, Mohammad Arshad, Norman Rostoker</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, Hydrogen/clean fuels, Industrial heat</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$9,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>9</td>
</tr>
<tr>
<td>General approach</td>
<td>Magneto-Inertial</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Stabilized Z-pinch</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron ‘blanket’</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>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.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2030</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>University of California San Diego, University of Rochester, Lawrence Livermore National Lab,</td>
</tr>
<tr>
<td>Spinouts/patents/innovations</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Recent published Papers**

### MARVEL FUSION

Marvel Fusion pursues a non-thermal direct drive inertial confinement approach with the goal of commercializing 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, Hydrogen/clean fuels, Industrial heat  
**Total declared funding to date**: $65,000,000  
**Employees (incl. full time consultants)**: 40  
**General approach**: Inertial confinement  
**Specific approach**: Laser-driven inertial confinement  
**Fuel Source**: pB11  
**Planned energy capture approach**: Direct energy conversion  
**Milestones in past 12 months**:
- Conducted experiments in US & Japan showing scaling for shorter laser wavelength and for the first time shooting experiments with nanostructures  
- Set up industrial consortium with Siemens, Thales, TRUMPF & others for power plant development  
- Manufactured first generation nanostructures  
- Raised EUR 35M Series A  
**Pilot plant timescale**: 2022-2025: upgrade existing laser systems and conduct experimental validation campaigns  
2027 prototype constructed and operational  
**Anticipated MWe of first commercial operating facility**: 500-2,000 MWe  
**Key collaborators/partners**: Siemens Energy, TRUMPF, Thales, Siegfried Glenzer, Florian Metzler, Ludwig Maximilian University of Munich  
**Recent published Papers**:

### N.T. TAO

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, Hydrogen/clean fuels  
**Total declared funding to date**: $5,500,000  
**Employees (incl. full time consultants)**: 11  
**General approach**: Magnetic confinement  
**Specific approach**: Modified Stellarator  
**Fuel Source**: DT  
**Planned energy capture approach**: Lithium neutron 'blanket'  
**Milestones in past 12 months**: Breakthrough in fast heating of high-density plasma  
**Pilot plant timescale**: Before end of decade  
**Anticipated MWe of first commercial operating facility**: 10-20 MWe

---

Note: The above information is extracted from the provided text and organized in a tabular format for clarity.
### NEARSTAR FUSION INC.

NearStar Fusion is developing a new pulsed approach to fusion called Hypervelocity Gradient Field Fusion (HGFF) that builds on successful methods of imploding metallic liners to create fusion energy and is also based in part on a NASA Innovative Advanced Concept study to produce fusion spacecraft propulsion.

<table>
<thead>
<tr>
<th>Location</th>
<th>Chantilly, Virginia, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:chris@nearstarfusion.com">chris@nearstarfusion.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2021</td>
</tr>
<tr>
<td>Founder Names</td>
<td>F. Douglas Witherspoon, Chris Faranetta</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, industrial heat, fusion propulsion</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$200,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>7</td>
</tr>
<tr>
<td>General approach</td>
<td>Inertial Fusion Energy</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Hypervelocity Gradient Field Fusion (HGFF)</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>Potentially all fusion fuels starting with DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron curtain for DT fuel</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Raising seed funding</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2032</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>Approximately 50 MWe with the goal of modular scaling up to gigawatt class production.</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>Fusion spacecraft propulsion, tunneling and shock physics research</td>
</tr>
</tbody>
</table>

### 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Cambridge, Massachusetts, USA</th>
</tr>
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<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:sales@nklabs.com">sales@nklabs.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2008</td>
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<tr>
<td>Founder Names</td>
<td>Ara Knaian, Seth Newburg</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation, Medical, Hydrogen/clean fuels, industrial heat, Tritium production</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$1,830,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>20</td>
</tr>
<tr>
<td>General approach</td>
<td>Muon-catalyzed fusion</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Muon-catalyzed fusion with high density fuel</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Liquid metal with heat exchanger</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>- Designed and built a detector and target assembly to measure the rate of muon-catalyzed fusion at high density</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2032: Construction of a plant showing commercial viability</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>100 MWe</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>ARPA-E, Fermilab, Paul Scherer Institute, University of Rochester Laboratory for Laser Energetics, York College, CERN</td>
</tr>
</tbody>
</table>
# PRINCETON FUSION SYSTEMS

Developing compact fusion reactors for modular and portable power systems.

<table>
<thead>
<tr>
<th>Location</th>
<th>Plainsboro, New Jersey, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:info@psatellite.com">info@psatellite.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>1992</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Michael Paluszek, Marilyn Ham</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$3,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>6</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Field Reversed Configuration</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DHe3</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Brayton cycle</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>Increased magnetic fields in experiments, electron heating, improved density</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2030</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>1 MWe</td>
</tr>
<tr>
<td>Key collaborator/partners</td>
<td>PPPL, GE Corporate Research, University of Rochester, Princeton University, NREL, Qorvo</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>Power electronics for RF heating and high current pulse generation. New fusion energy toolbox for MATLAB</td>
</tr>
</tbody>
</table>
PRINCETON STELLARATORS
Princeton Stellarators is leveraging recent breakthroughs and IP that revolutionize stellarator technology. The company’s fusion systems will create a limitless source of zero emission energy for a sustainable future of humanity.

| Location                  | Princeton, New Jersey, USA
|                          | New York, USA          |
| Contact Details           | Info@PrincetonStellarators.energy |
| Year founded              | 2022                   |
| Founder Names             | David Gates, Brian Berzin, Matt Miller |
| Primary target markets    | Electricity generation, Medical, Tritium production |
| Total declared funding to date | Not disclosed |
| Employees (incl. full time consultants) | 10 |
| General approach          | Magnetic confinement   |
| Specific approach         | Stellarator            |
| Fuel Source               | DT                     |
| Planned energy capture approach | Lithium neutron ‘blanket’ |
| Milestones in past 12 months | Company founded and initial funding. Prototyped magnet technology. |
| Pilot plant timescale     | Q>1 prototype stellarator system before 2030. |
| Anticipated MWe of first commercial operating facility | >250MWe |
| Key collaborators/partners | Princeton University. |

REALTA FUSION
Realta Fusion is an early-stage spin-out from the University of Wisconsin-Madison developing a modular fusion reactor. The compact, high magnetic field, tandem mirror reactor offers significant advantages in terms of reliability, maintenance, and operability. Realta is targeting initial uses in process heat.

| Location                  | Madison, Wisconsin, USA |
| Contact Details           | info@realtafusion.com   |
| Year founded              | 2022                   |
| Founder Names             | Cary Forest, Kieran Furlong, Jay Anderson, Oliver Schmitz, Ben Lindley |
| Primary target markets    | Industrial heat         |
| Total declared funding to date | Not disclosed |
| General approach          | Magnetic confinement   |
| Specific approach         | Magnetic mirror        |
| Fuel Source               | DT                     |
| Planned energy capture approach | Lithium neutron ‘blanket’ |
| Key collaborators/partners | ARPA-E                 |
### 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** | 2020 |
| **Founder Names** | Francesco Volpe, Martin Kupp |
| **Primary target markets** | Electricity generation, Medical |
| **Total declared funding to date** | $16,500,000 |
| **Employees (incl. full time consultants)** | 14 |
| **General approach** | Magnetic confinement |
| **Specific approach** | Stellarator |
| **Fuel Source** | DT |
| **Planned energy capture approach** | Liquid metal with heat exchanger |

**Milestones in past 12 months**
- Finalized pre-seed funding and laid ground for seed (multi-M€) round
- Consolidated organization to reach 14 employees
- Filed 10 patents
- Moved into a 900 m² office+lab space
- Performed system analysis of stellarator power-plant design point
- Identified optimal plasma equilibrium and stellarator coil geometry
- Modelled innovative HTS manufacturing procedure
- Analyzed free-surface, full-coverage liquid metal flow experiment extrapolating to reactor scale

**Pilot plant timescale**
2027: small-scale net-heat demonstrator (Q>1)
2032: full-size net-electricity reactor connected to the grid

**Anticipated MWe of first commercial operating facility**
1000 MWe

**Key collaborators/partners**
BPI France, CEA, INRIA, Lorraine University, Strasbourg University, Sorbonne University (France), Tuscia University (Italy), Instituto Superior Técnico Lisboa (Portugal) AMPeers LLC, PPPL, University of Houston, Savannah River National Laboratory, Brookhaven National Laboratory (USA)

**Spin outs/patents/innovations**
Medical imaging magnets, magnetic energy storage
TAE TECHNOLOGIES
TAE Technologies (founded as Tri Alpha Energy) is forging the path to cost-effective, commercial fusion energy. Through its unique approach to fusion, TAE has developed spinoff applications in energy storage, electric mobility, life sciences, and more to create a complete clean energy ecosystem.

<table>
<thead>
<tr>
<th>Location</th>
<th>California, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td>Media: <a href="mailto:press@tae.com">press@tae.com</a> Public Policy: <a href="mailto:pga@tae.com">pga@tae.com</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>1998</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Numerous founders</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$1,000,000,000+ ($1bn)</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>~400</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Field Reversed Configuration</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>p-B11; TAE configuration can accommodate all available fusion fuel cycles</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Heat capture and conventional thermal cycle and / or future direct energy conversion</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>75M+ degrees Celsius on Norman platform, 2022</td>
</tr>
<tr>
<td>Construction Status</td>
<td>Presently operating fifth-generation National Lab-scale machine, Norman; siting / construction underway for sixth-generation net energy machine, Copernicus</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>2025: Copernicus will prove the viability of net energy demonstration. 2030s: Commercialization of Da Vinci device, the world’s first prototype p-B11 / hydrogen-boron fusion power plant. For complete device timeline, see TAE.com/history</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>350-500 MWe</td>
</tr>
<tr>
<td>Key collaborators/partners</td>
<td>Google, U.S. National Laboratories, Japan’s National Institute for Fusion Science. For complete list, see TAE.com/collaborators</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>TAE Life Sciences - targeted cancer therapy; TAE Power Management - energy storage, electric mobility, off-grid/micro-grid, fast charging, and more. Over 1100 granted patents to date.</td>
</tr>
<tr>
<td>Recent published Papers</td>
<td>For complete list, see TAE.com/research-library</td>
</tr>
</tbody>
</table>
**TOKAMAK ENERGY**

Tokamak Energy Ltd is pioneering commercial fusion energy based on compact spherical tokamaks with high temperature superconductor (“HTS”) magnets. The company operates the ST40 spherical tokamak which has achieved 100 million degree plasma temperature and has demonstrated a 26T compact HTS magnet, tested at CERN.

<table>
<thead>
<tr>
<th>Location</th>
<th>Oxford, UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:info@tokamakenergy.co.uk">info@tokamakenergy.co.uk</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2009</td>
</tr>
<tr>
<td>Founder Names</td>
<td>David Kingham, Mikhail Gryaznevich, Alan Sykes</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$250,000,000</td>
</tr>
<tr>
<td>Employees (incl. full time consultants)</td>
<td>190</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Spherical tokamak</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Lithium neutron 'blanket'</td>
</tr>
<tr>
<td>Milestones in past 12 months</td>
<td>100 million degree plasma ion temperature in ST40 prototype.</td>
</tr>
<tr>
<td>Pilot plant timescale</td>
<td>Early 2030s with a major device combining HTS magnets with the spherical tokamak by 2026</td>
</tr>
<tr>
<td>Anticipated MWe of first commercial operating facility</td>
<td>500MWe</td>
</tr>
<tr>
<td>Spin outs/patents/innovations</td>
<td>Over 55 families of patent applications, many covering HTS magnets</td>
</tr>
</tbody>
</table>
## 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
contact@xcimer.net

### Year founded
2022

### Primary target markets
Electricity generation

### Total declared funding to date
Not disclosed

### Employees (incl. full time consultants)
10

### General approach
Inertial confinement

### Specific approach
Laser-driven inertial confinement

### Fuel Source
DT

### Planned energy capture approach
FLiBe waterfall ‘blanket’

### Pilot plant timescale
- Demonstration Laser Facility: 2025
- MJ-scale Laser Facility: 2028
- Pilot facility demonstrating commercial viability: 2032

### Anticipated MWe of first commercial operating facility
1 GWe

### Key collaborators/partners
- University of Wisconsin- Madison, MIT/CFS, ORNL, IPP, SRNL
- Key collaborators:
  - Randall Volberg, David Anderson, Chris Hegna, John Canik, Paul Harris

### Spin outs/patents/innovations
- Stellarator Optimization
- Advanced Mfg for Fusion Reactors
- HTS Magnets for Stellarators

### Recent published Papers
- Improving the stellarator through advances in plasma theory, Nuclear Fusion, Volume 62, Number 4

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## Type One Energy Group

Type One is commercializing the stellarator fusion concept, the ultimate clean power source, and making it affordable and available to all.

### Location
Madison, Wisconsin, USA

### Contact Details
projects@typeoneenergy.com

### Year founded
2019

### Founder Names
Randall Volberg, David Anderson, Chris Hegna, John Canik, Paul Harris

### Primary target markets
Electricity generation, Hydrogen/clean fuels, Industrial heat

### Total declared funding to date
$51,750,000

### Employees (incl. full time consultants)
10

### 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
2035

### Anticipated MWe of first commercial operating facility
500 MWe

### Key collaborators/partners
University of Wisconsin- Madison, MIT/CFS, ORNL, IPP, SRNL

### Spin outs/patents/innovations
Stellarator Optimization, Advanced Mfg for Fusion Reactors, HTS Magnets for Stellarators

### Recent published Papers
Improving the stellarator through advances in plasma theory, Nuclear Fusion, Volume 62, Number 4
ZAP ENERGY
Zap Energy is building a low-cost, compact, scalable fusion reactor with no magnets and the potential for a short path to commercially viable fusion energy.

<table>
<thead>
<tr>
<th>Location</th>
<th>Seattle, Washington, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Details</td>
<td><a href="mailto:reachout@zap.energy">reachout@zap.energy</a></td>
</tr>
<tr>
<td>Year founded</td>
<td>2017</td>
</tr>
<tr>
<td>Founder Names</td>
<td>Benj Conway, Brian Nelson, Uri Shumlak</td>
</tr>
<tr>
<td>Primary target markets</td>
<td>Electricity generation</td>
</tr>
<tr>
<td>Total declared funding to date</td>
<td>$200,000,000</td>
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<tr>
<td>Employees (incl. full time consultants)</td>
<td>60</td>
</tr>
<tr>
<td>General approach</td>
<td>Magnetic confinement</td>
</tr>
<tr>
<td>Specific approach</td>
<td>Z-pinch</td>
</tr>
<tr>
<td>Fuel Source</td>
<td>DT</td>
</tr>
<tr>
<td>Planned energy capture approach</td>
<td>Liquid metal with heat exchanger</td>
</tr>
</tbody>
</table>

Milestones in past 12 months:
- Added over 40 employees and tripled in size.
- Increased power, performance and diagnostics of SFS Z pinches on FuZE prototype core, including operation at 500 kA of pinch current.
- Built next generation FuZE-Q device, which began operations summer 2022.

Pilot plant timescale:
Planning for a demonstration plant mid-2020’s and a first-of-a-kind plant in 2030. Have begun initial discussions on first-of-a-kind pilot plant siting.

Anticipated MWe of first commercial operating facility:
Each module is anticipated to be roughly 50 MWe, allowing scaling from small plants to GWe.

Key collaborators/partners:
University of Washington; Lawrence Livermore National Lab; Los Alamos National Lab; Lawrence Berkeley National Lab; University of Nevada, Reno; DOE ARPA-E; University of California, San Diego; Woodruff Scientific.

Recent published Papers: