Nuclear Energy BLUprint

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Acknowledgement

Nuclear energy technology has emerged as a critical enabler for global decarbonization, attracting unprecedented government and private sector commitment. This sentiment can be observed globally, with the International Energy Agency revising its nuclear capacity projections to reach upwards of 916 GWe by 2050, which is more than 2x its current installed base.

The investment landscape also reflects this strong and strategic shift, with PE and VC flows to advanced nuclear companies reaching a record high in 2024, 13x compared to 2023. We are currently at a fundamental inflection point where nuclear technology starts the transition from government supported research to commercially viable, venture scalable opportunities. This presents a rare opportunity to invest in technologies with massive markets, strong regulatory tailwinds, and genuine strategic importance – characteristics that drive outsized returns in infrastructure scale investments.

I want to acknowledge the contribution of **Atharv Apshinge** on this thesis in analysing the nuclear energy industry and helping identify investment opportunities and risks & white spaces, technological and scientific developments, applications, use-cases, and government policies.

If you are a founder, researcher or stakeholder in nuclear tech, and would be interested to chat more about our work or discuss yours, feel free to reach out at akhilesh@blume.vc

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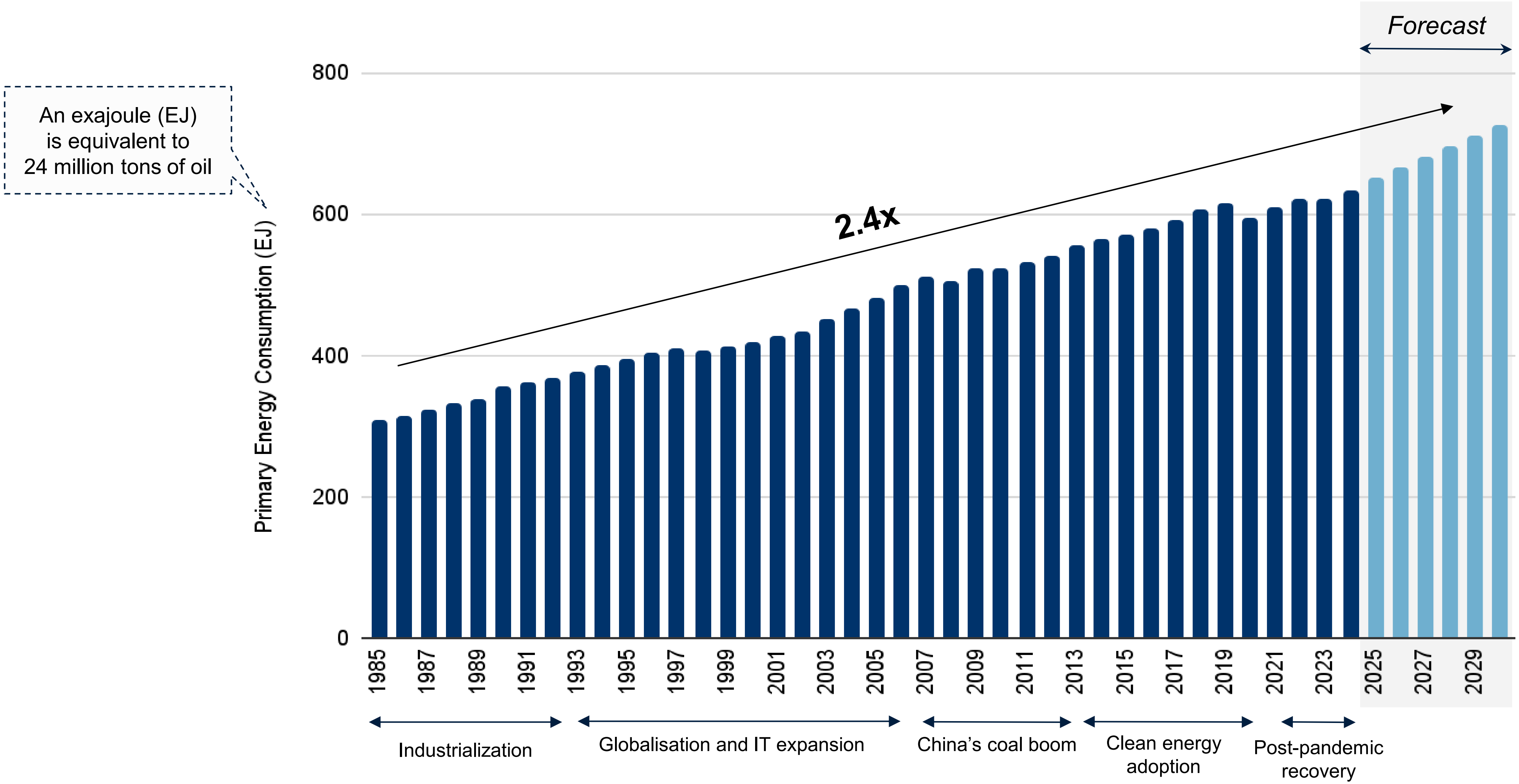
Global energy consumption is ever rising…

By 2030, a 14% increase (vs 2024) in the global energy consumption is predicted owing to AI driven load on data centres, electric mobility adoption and industrial electrification, with most growth observed in developing countries



Source: International Energy Agency, Statista, BP. Note: Primary energy consumption refers to the total energy used before it is converted into other forms of energy or consumed directly.

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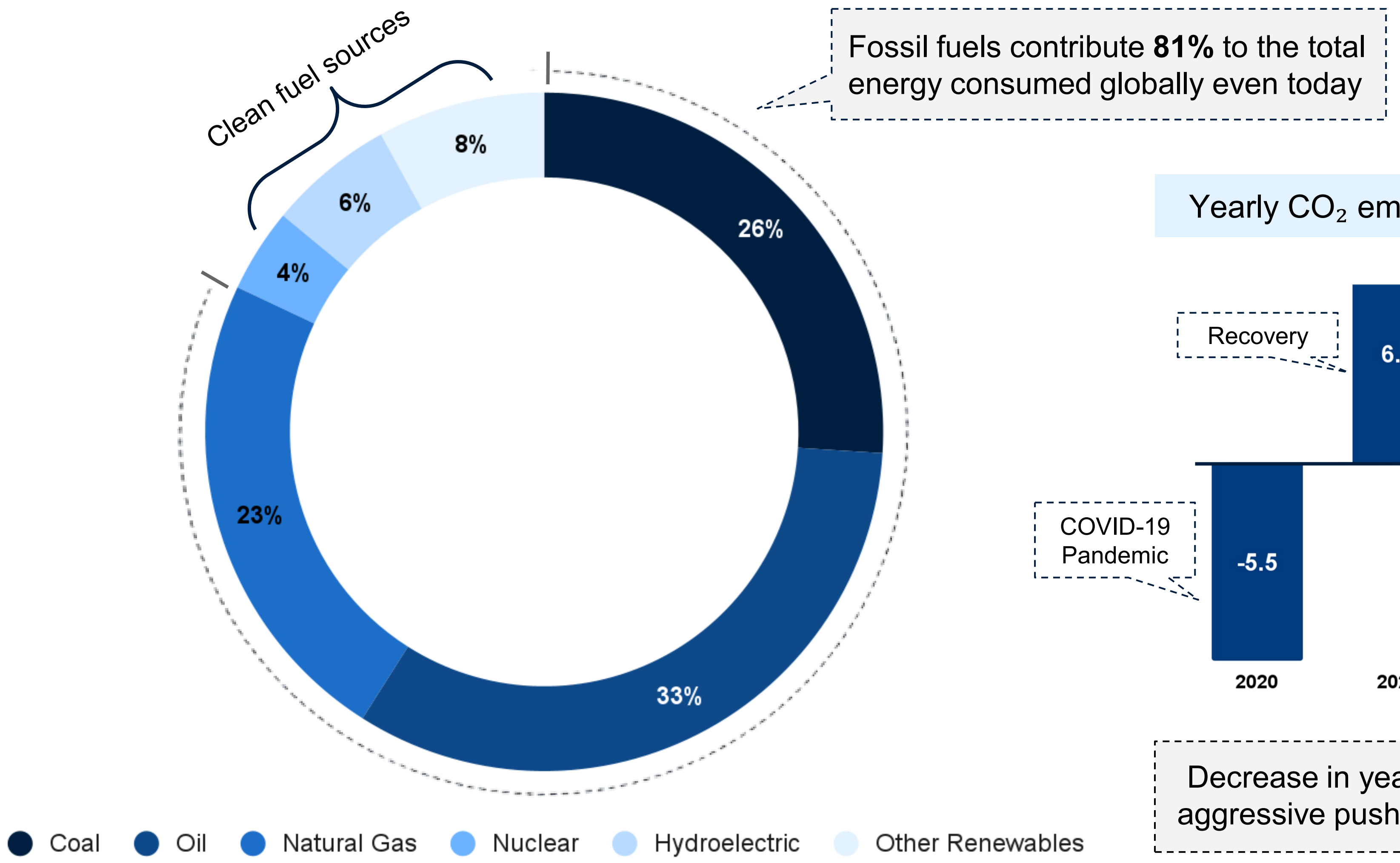
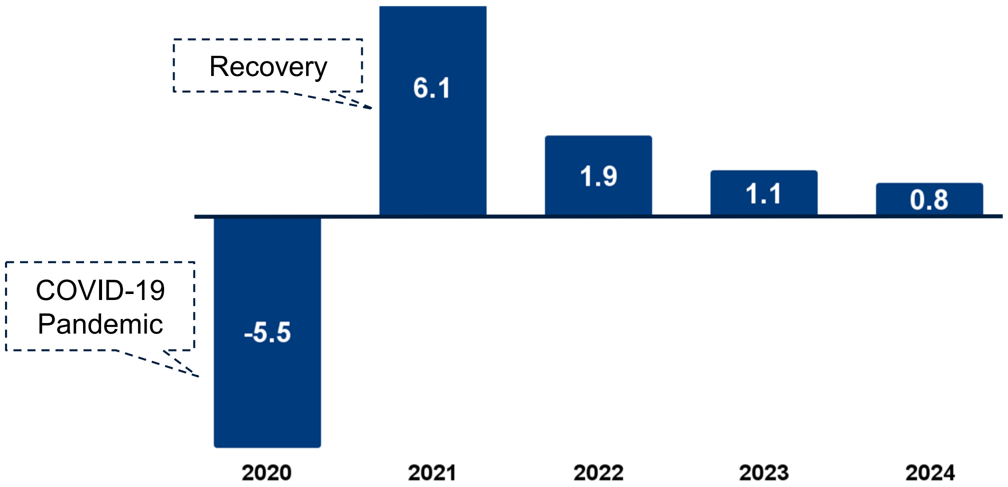
…and so are CO_2 emissions

To keep global warming below 1.5°C – a necessary threshold for averting severe climate impacts, we must hit net-zero emissions by 2050, removing every ton of CO_2 released from fossil fuel combustion



Yearly CO_2 emissions – Annual Growth Rate (%)

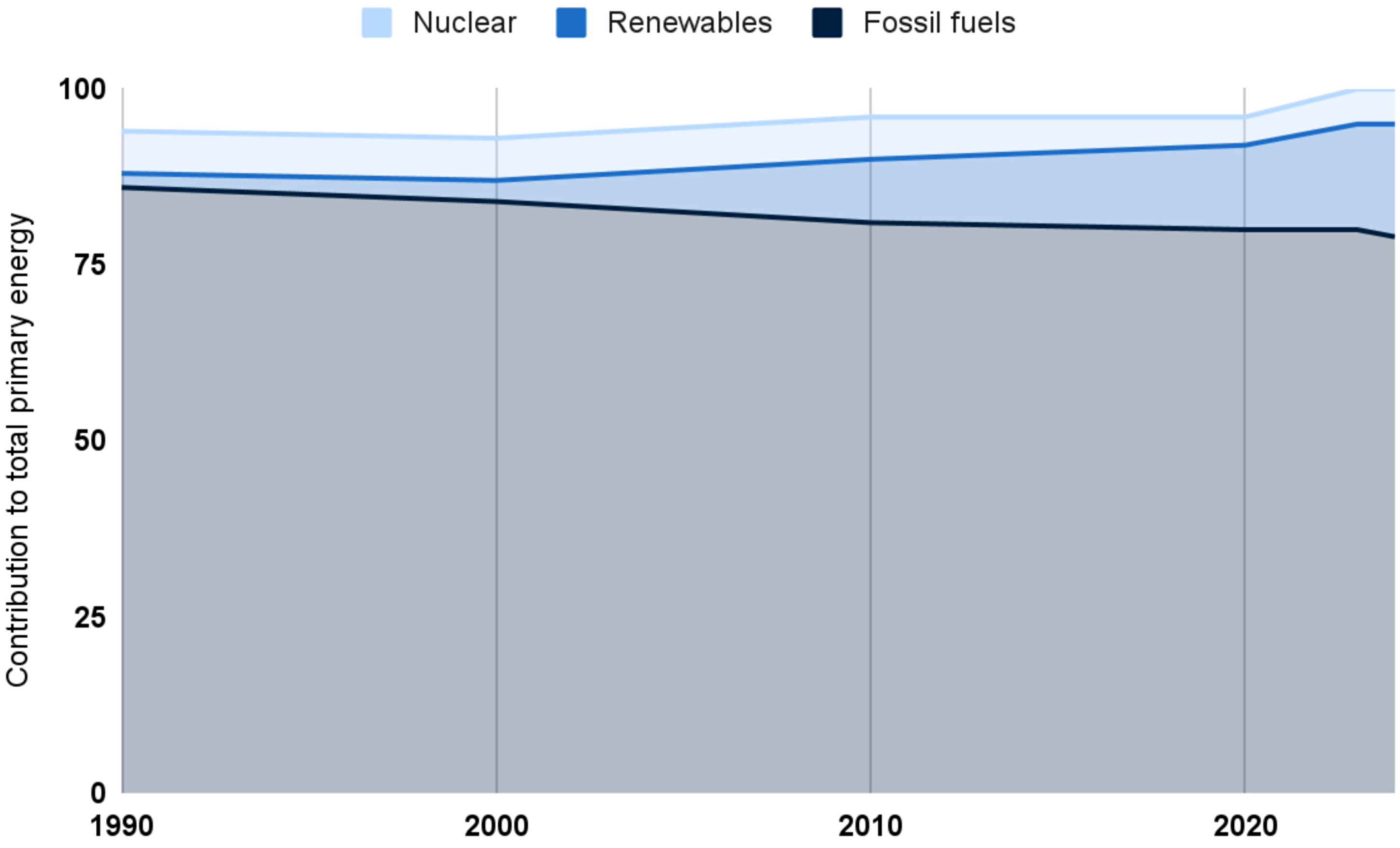


Decrease in yearly CO_2 emissions recently is due to aggressive push by governments to adopt clean fuels

Source: MSCI Sustainability Institute, Global Carbon Project, Blume Research

Net-zero efforts have yielded bold gains, yet a long road remains

Clean fuels have nearly tripled their share of total energy consumption to ~22% since 1990, nuclear power generation has remained underutilized, holding steady at just 5–6%



*does not add up to 100% because it excludes certain smaller contributors and rounding adjustments in data

Opportunity and Challenges in Nuclear Energy

- Nuclear plants operate at 90% capacity and **produce maximum power 3x more reliably than wind or solar**, meaning that replacing 1GW of nuclear output requires setting up 3GW of wind or solar capacity
- Nuclear requires **30x less land than solar and 170x less than wind**
- High energy density, 24x7 baseload power and cost-effectiveness over time makes nuclear power promising, but underutilized
- Gen-IV reactors aim to reuse 95% of spent fuel
- **High up-front costs** and **public perception about the safety** has hindered the growth of nuclear energy

Source: Blume Analysis, Nuclear Energy Institute, U.S. Department of Energy

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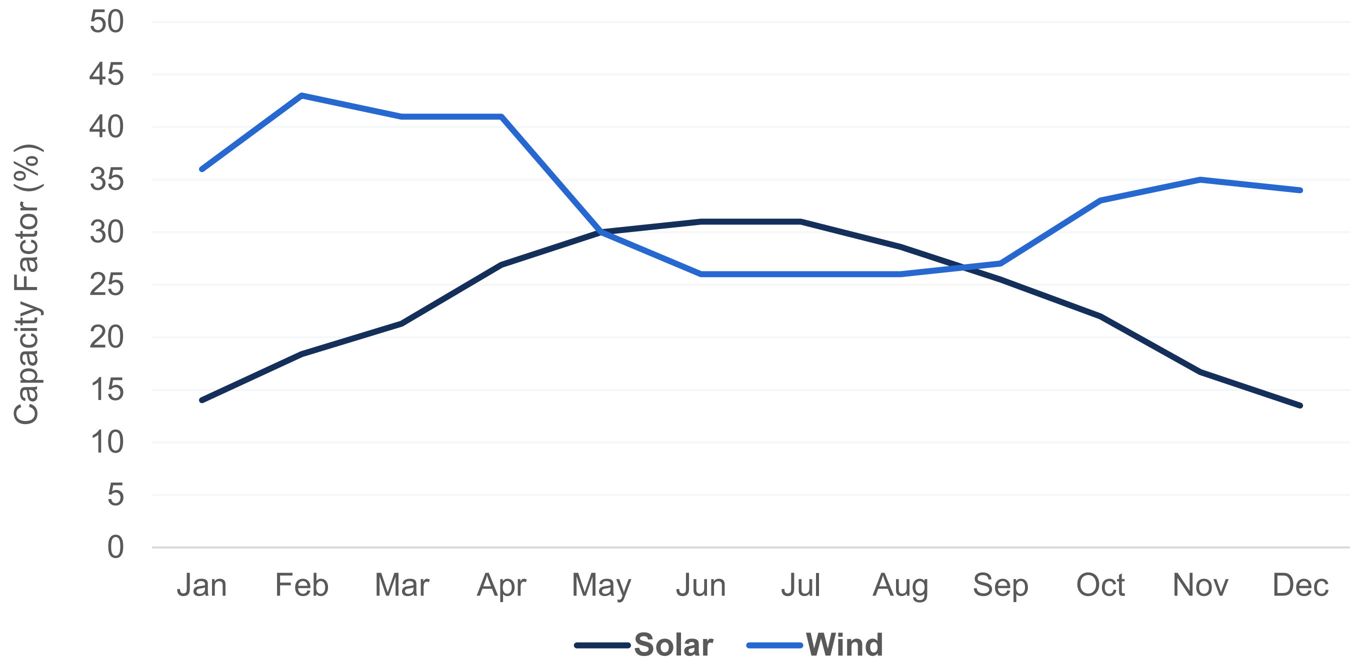
Nuclear's 24/7 reliability becoming the dark horse of tech infra bets

A clear commercial viability, adoption and strategic investment in nuclear can be seen from the lens of hyperscalers, validated by recent developments

Average generation capacity of wind and solar plants in US (2023)



AI and data centre energy demands are projected to increase 5x by 2035, and renewables will not be able to meet this demand even after being coupled with a robust energy storage infra, as these data centres need continuous baseload power which can be achieved through nuclear (>90% vs 25-35% CF of wind, solar) or natural gas only.

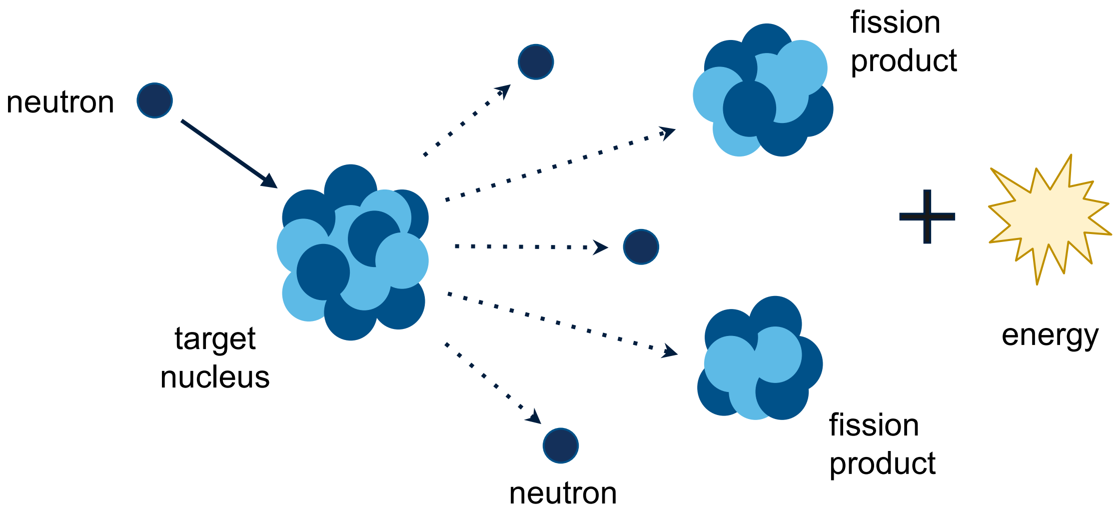
Big Tech Company	Nuclear Partner
Microsoft	Constellation
Google	Kairos Power
amazon	X energy

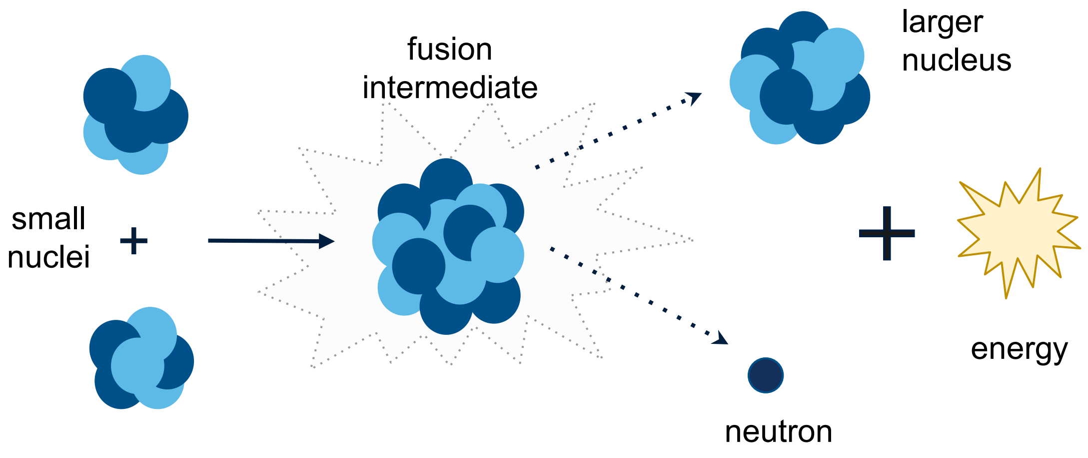
- Microsoft has emerged as the most aggressive investor, their 20 year deal with Constellation shows nuclear's premium valuation in PPAs
- Google's 500MW advanced nuclear plant with Kairos Power and Amazon's $500m investment in X-energy SMRs highlight nuclear pivot for AI/data center needs being made by tech giants

Source: Goldman Sachs, CB Insights, Blume Research

Nuclear is the second largest source of low-carbon power

Fission currently delivers 25% of the world's low-carbon electricity, but fusion promises 4x energy per kilogram of fuel compared to fission, produces no long-lived radioactive waste, near-zero CO_2 emissions and uses fuel that will last forever or can be bred using advanced techniques





Fission

- Splits heavy isotopes (eg. uranium-235) in a controlled chain reaction, releasing thermal energy, then converted to electricity
- Mature, scalable, and decarbonizing grids today, but faces challenges in radioactive and hazardous waste management

Fusion

- Merges light nuclei under stellar conditions to form heavier nucleus and release of energy, then converted to heat/electricity
- Promises near-zero waste and limitless fuel, but requires breakthrough in net energy gain (Q>1) for commercialization

Source: Blume Research

Nuclear fission

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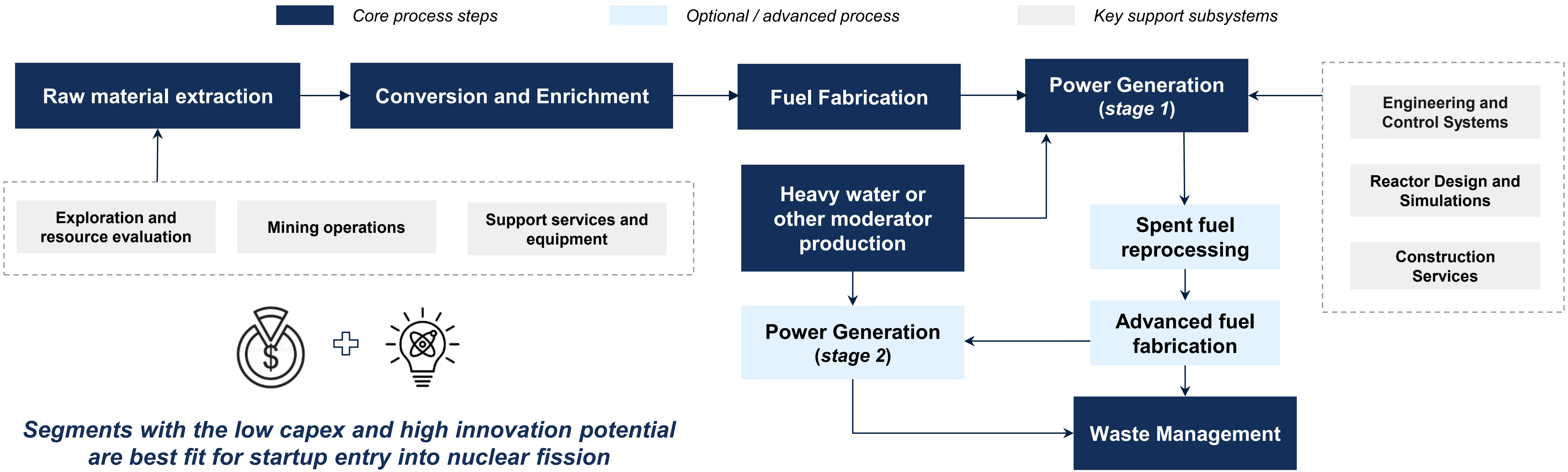
Subsystem mapping across process flow for white spaces (1/3)

Most nuclear fission projects are high capex projects, so startups should enter through very niche, but high value segments with lower entry barriers and upfront investments



Segments with the low capex and high innovation potential are best fit for startup entry into nuclear fission

Engg and control systems are software and electronics-heavy, startups can build advanced digital twins of real systems for reactor monitoring, predictive maintenance, process automation solutions like micro robots for inspecting narrow piping and fuel assemblies, etc.

Waste to Value technologies like spent fuel recycling through robotic reprocessing and AI based yield optimization.

These products and services can be designed for **Small Modular Reactors** which are the future tech as they offer energy independence and a faster development cycle.

Subsystem mapping across process flow for white spaces (2/3)

Mining, milling and raw material processing is dominated by established companies, requires heavy infrastructure for operational activities. Similar trend observed in case of conversion and enrichment plants. Segments with startup entry and innovation potential highlighted below.

Raw Material Extraction

- AI, remote sensing, and geospatial analytics to revolutionize exploration and resource evaluation
- Extraction from seawater and marine offers limitless uranium, breakthroughs in adsorbent materials and electrochemical reactors are needed
- In-situ recovery (ISR) mining lowers upfront capex and surface disturbance compared with conventional operations, innovation in process engineering required.
- Steep capital requirements and stringent regulations throughout the fission raw-material supply chain makes VC funding less prevalent here

Denison Mines, Deep Yellow Limited, Bannerman Energy, Cameco, GoviEx Uranium, Kazatomprom, Orano, UEC Uranium Energy Corp, Boart Longyear, Cementation (We build mines. Safely.), Energy Fuels, Paladin, SRK Consulting, Caterpillar, NexGen Energy Ltd.

Conversion and Enrichment

- Enrichment niches, particularly laser isotope separation and emerging chemical separation methods present high value opportunities, though they remain subject to export controls and require substantial R&D investment
- Equipment and digital services from advanced centrifuge rotor design to AI driven process controls and remote monitoring position software and hardware vendors as enablers in the front end of the fuel cycle.
- Specific government incentives funding down blending contracts and pilot scale demonstrations are reducing market entry barriers (eg. HALEU solutions)

ConverDyn, Tenex Rosatom, Urenco, Global Laser Enrichment, Centrus (Fueling the Future of Nuclear Power), Silex (Laser based uranium enrichment), GE Vernova, Honeywell UOP, BWXT BWX Technologies, Inc., Ubaryon, General Matter, LIS Technologies Inc.

Fuel fab

Reactor design and power generation

Waste Management and Recycling

Source: Blume Research

Subsystem mapping across process flow for white spaces (3/3)

Most nuclear fission projects are high capex projects, so startups should enter through very niche segments of the value chain with lower entry barriers and upfront investments

Raw material extraction

Conversion and enrichment

Fuel fab

- Modular fuel fab units that can be installed near power plants to reduce transportation challenges and cost
- High-Assay Low-Enriched Uranium (HALEU) production facilities to support advanced reactors
- Research into microfluidic sol-gel techniques allowing for the fabrication of uniform fuel microspheres, improving fuel consistency and reactor performance

Reactor Design and Power Generation

- Key themes where rapid innovations are happening in reactor design and development are – Small Modular Reactors (SMR), Molten Salt Reactors (MSR), Gas cooled, and Fast Breeder Reactors (FBR)
- Microreactors and portable solutions for off grid capabilities are receiving govt grants for developing solutions for military and space
- Secondary stage reactors that re-use processed fuel and prolong the fuel cycle

Waste Management and Recycling

- Pyroprocessing and hydrometallurgical methods are reshaping fuel recycling by enabling efficient recovery of uranium, plutonium, and minor actinides.
- AI driven systems for optimizing, recycling and monitoring waste.
- Robotic systems for remote waste handling
- Closed-loop fuel cycles to recycle spent fuel, cutting high-level waste volumes
- MOX and HALEU fuel technologies

X energy, Westinghouse, framatome, GNF Global Nuclear Fuel, NFC

OKLO, X energy, DEEP FISSION, NUSCALE, LAST ENERGY, RADIANT, TERRESTRIAL ENERGY, newcleo, NANO Nuclear Energy Inc., Rolls Royce SMR, BLOSSOM ENERGY, ANTARES

moltex clean energy, CURIO, JNFL, SHINE, TRANSMUTEX, Alpha Nur, PermaFix environmental services, SOGIN, Studsvik, ROSATOM, zeno

Source: Blume Research

Pressurised Water Reactors are the most common, commercialized fission tech right now

SMRs built on the principle of PWRs, with lower power outputs and a modular setup, are reshaping nuclear energy through low capex, scalable systems

	PWR	BWR	HWR	FNR/FBR	MSR	SMR
Efficiency						
CapEx						
Power density						
Emissions						
Tech maturity	**Commercial**	**Commercial**	**Commercial**	**Limited Commercial**	**Prototype**	**Demo/Deployment**
Approximate no. of reactors	**300**	**60**	**40**	**<10**	**-**	**-**

PWR = Pressurized Water Reactor, BWR = Boiling Water Reactor, HWR = Heavy Water Reactor, FBR = Fast Breeder Reactor, MSR = Molten Salt Reactor, SMR = Small Modular Reactor

Source: Blume Analysis. Note: This is an evolving landscape and we expect consistent disruption in this benchmarking.

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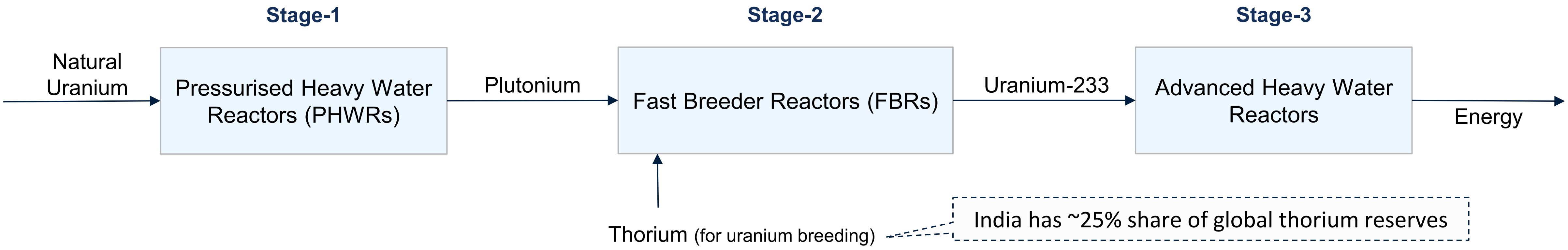
India’s $2.4bn budget addition to the Nuclear Energy Mission signals a bold leap

India’s fission value chain is largely government-controlled, leading to slower growth due to limited competition and lack of market-driven incentives, but this has started to change in recent times

India’s three stage Nuclear Programme aimed to build a closed fuel cycle and reduce dependence on fuel imports



Indian founders and investors can look at niche themes to enter the fission market, here are some examples

Advanced Nuclear Fuel Tech: Startups can develop TRISO fuel manufacturing capabilities. The production process involves coating uranium, thorium, or plutonium kernels with ceramic materials to improve reliability and efficiency

Robotics and Automation: Companies like Genrobotics developing specialized cleantech robots for hazardous environments, demonstrates potential in nuclear. AI robotics for fuel assembly inspection, reactor vessel maintenance, and nuclear waste handling

Thorium based Fuel Innovation: The three stage nuclear program explicitly incorporates thorium utilization in Stage-2 Fast Breeder Reactors and Stage-3 Advanced Heavy Water Reactors, creating systematic demand for thorium-based fuel technologies

Source: Blume Research

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Shaping the future of energy through
Nuclear Fusion

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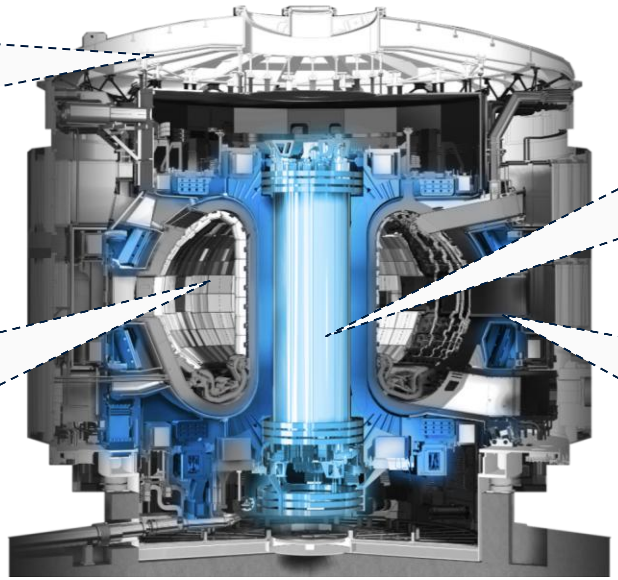
Magnetic Confinement Fusion leads the scene with highest investments and collaborations

Over half of fusion reactor projects rely on MCF, with flagship megaprojects like ITER – $22bn budget and supported by 35 nations, leading the charge

Cryogenic systems support vacuum and thermal stress on reactor. They are also important to cool superconducting magnets below their critical temperatures

Fuel gas ionized into plasma is injected and heated to fusion temperatures using **RF**, **neutral beams** inside the **vacuum vessel**, it flows around with high K.E. enough to overcome repulsive forces and fuse



ITER's tokamak design

These **magnets** generate electromagnetic fields to keep plasma stable and away from the reactor wall – no physical material can directly confine plasma due to its super high temperature

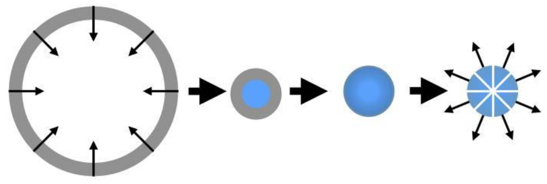
High-energy neutrons escape the plasma, striking a **Li-based blanket** that captures their heat and breeds new tritium fuel. A coolant carries heat to a conventional steam cycle - turbine and generators

- Startups are trying to address bottlenecks like plasma stability, coil heating and cooling, driver efficiency, maintenance turnaround, etc.
- Companies commercializing relevant subsystems (CFS for HTS, Tokamak Energy for liquid-metal walls) will be good strategic investments
- For example, the use of ***High Temperature Superconducting (HTS) Magnets*** offered 3-4x stronger magnetic fields to confine plasma. These magnets have low resistance leading to lesser heating of coils and hence simpler cryogenics

Source: Blume Research, ITER

Inertial Confinement Fusion promises a faster path to fusion power

The MCF technique requires a greater power input than what it generates and remains a challenge even today. But ICF has successfully demonstrated a 2.4x energy gain as the output, signalling towards stable grid supply before 2035



ICF process schematic

Small spherical target filled with **fuel is shot with high energy laser/ion beams** which vaporizes the shell outwards, and compresses the fuel inwards (inertia at play)

→ The fuel is compressed by ~1000x its original density, achieving high temperature of ~100 million K, which **starts fusion reaction** from the centre (ignition zone)

→ Fusion leads to **release of high energy neutrons and other particles** outwards, which can be captured by walls or blankets, to drive a turbine or generator

1 Energy Driver System
(lasers, pulsed power, ion beams, optics)

Function: Deliver high energy to compress and heat the fuel pellet

Challenges: Achieving extremely high power, energy efficiency, reliability, repetition rate, and cost-effectiveness of laser or pulsed power systems. Beam quality, synchronization, uniform energy delivery.

2 Target System
(fabrication, injection, tracking)

Function: Pellets/targets contain fuel, then delivered to reaction chamber at high repetition rates

Challenges: Manufacturing defect free capsules with micron level uniformity, layering and doping for optimal ablation and compression. Injection and tracking - ultra precise alignment, timing with driver system

3 Reaction Chamber, First Wall and Breeding Blanket

Function: Contain fusion reaction, absorb energy, manage debris, produce and recycle tritium fuel via Li blankets

Challenges: Walls withstanding strong neutron flux, x-rays, debris from repeated micro-explosions. Remote maintenance and rapid replacement. Efficient tritium breeding, handling economically

4 Diagnostics, Control, Simulation, Energy Systems

Function: Monitor, control, capture, process, simulate parameters of the rapid fusion process. Capture and convert energy released into heat/electric

Challenges: High speed sensors, imaging, predictive control, dynamic adjustments. Efficient capture and conversion of heat from neutrons

Source: Blume Research

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Many innovative ideas and prototypes for fusion have emerged

Startups have come up with newer approaches for achieving fusion with the promise of a faster development than the popular tokamaks and stellarators

MCF (tokamak)

iter
Commonwealth Fusion Systems
Tokamak Energy
STARTORUS FUSION
KFE
能量奇点 ENERGY SINGULARITY

MCF (stellarator)

Proxima Fusion
Helical Fusion
GAUSS FUSION
nT-tao
RENAISSANCE FUSION
TYPE ONE ENERGY

MCF (others)

REALTA FUSION
DEUTELIO
NOVATRON

MTF / MIF

ELECTRIC FUSION SYSTEMS
HELION
tae
generalfusion
nearstar FUSION
fuse

ICF

FOCUSED ENERGY
LPPFUSION
EX-Fusion
HB11 ENERGY
BLUE LASER FUSION
MarvelFusion

Z-pinch fusion

ZAP ENERGY
MIFTI

Others

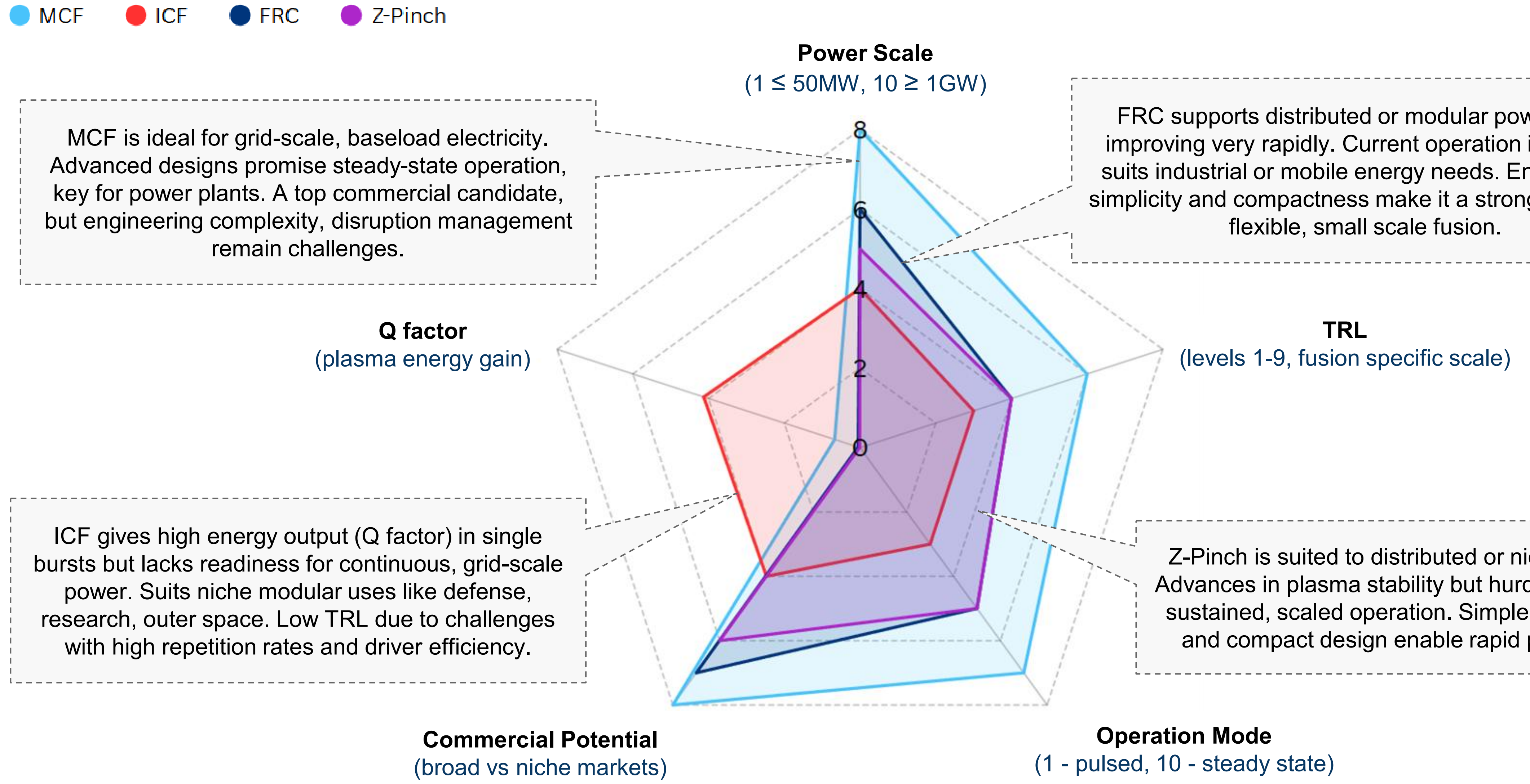
CROSSFIELD FUSION
acceleron
DEUTERIUM ENERGETICS
AVALANCHE

Fusion technology is still in its infancy, **no approach has achieved net energy gain at the system level** – commercialization remains distant. Even though it is unclear which fusion pathway will prove most viable, it is key to understand the strengths and challenges in each.

Source: Blume Research

MCF is most scaled and developed; ICF leads in net energy gain

Grid based power supply is not the only application of fusion, at current stage ICF, FRC and Z-Pinch promise high-value niche use cases in near-term



MCF is ideal for grid-scale, baseload electricity. Advanced designs promise steady-state operation, key for power plants. A top commercial candidate, but engineering complexity, disruption management remain challenges.

FRC supports distributed or modular power. TRL improving very rapidly. Current operation is pulsed, suits industrial or mobile energy needs. Engineering simplicity and compactness make it a strong option for flexible, small scale fusion.

ICF gives high energy output (Q factor) in single bursts but lacks readiness for continuous, grid-scale power. Suits niche modular uses like defense, research, outer space. Low TRL due to challenges with high repetition rates and driver efficiency.

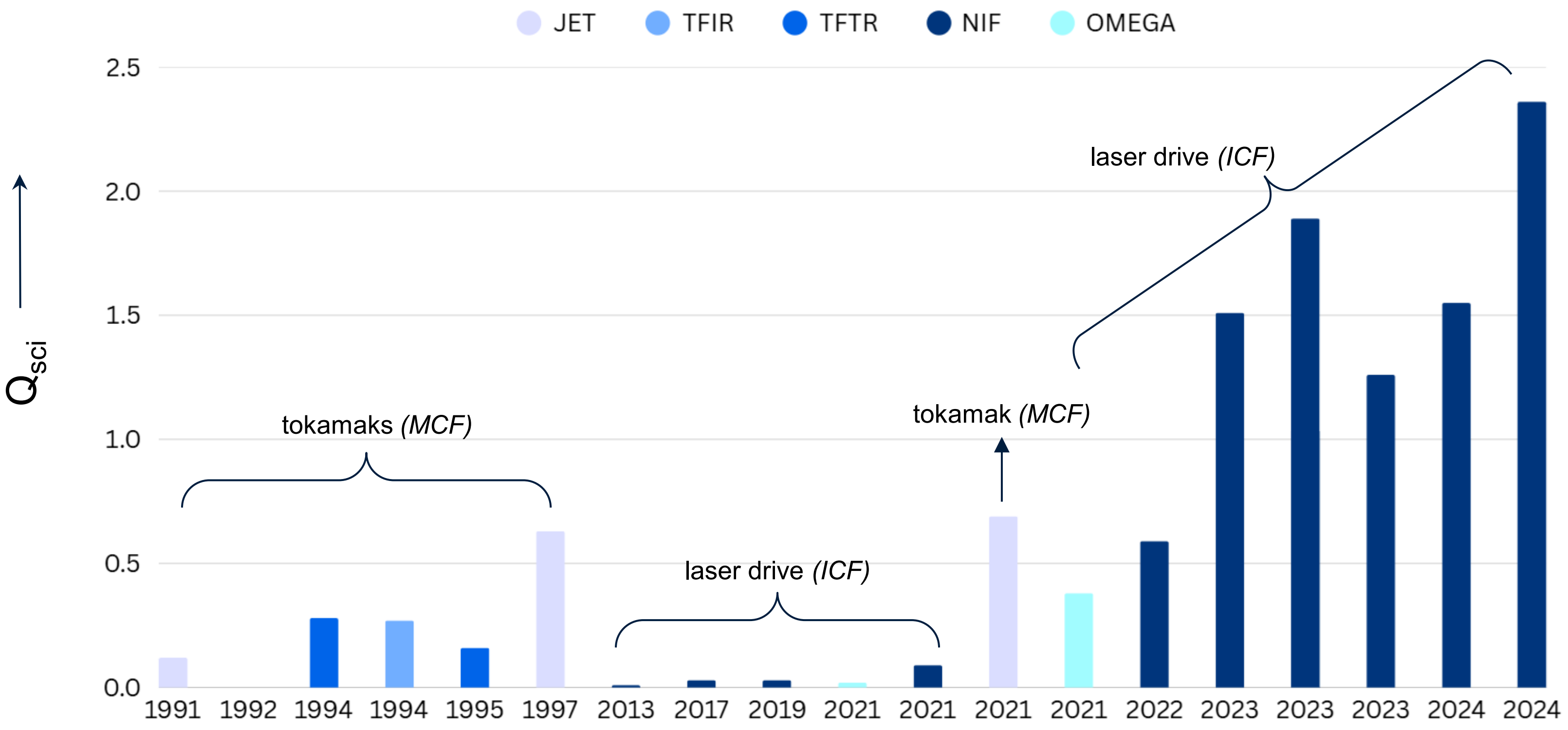
Z-Pinch is suited to distributed or niche markets. Advances in plasma stability but hurdles remain for sustained, scaled operation. Simpler engineering and compact design enable rapid prototyping.

Source: Blume Analysis. Note: FRC is one of the leading fusion method under Magneto-Inertial Fusion (MIF) and has received high private investments this year, following high innovation

Net energy gain is the first step towards a fusion–powered future

We are way behind in achieving system-level net energy gain, without which fusion power generation will be irrelevant, but progress has been rapid in the recent years

Ratio of energy produced by fusion reaction (**fusion output**) to energy used specifically to heat plasma (**heating input**)



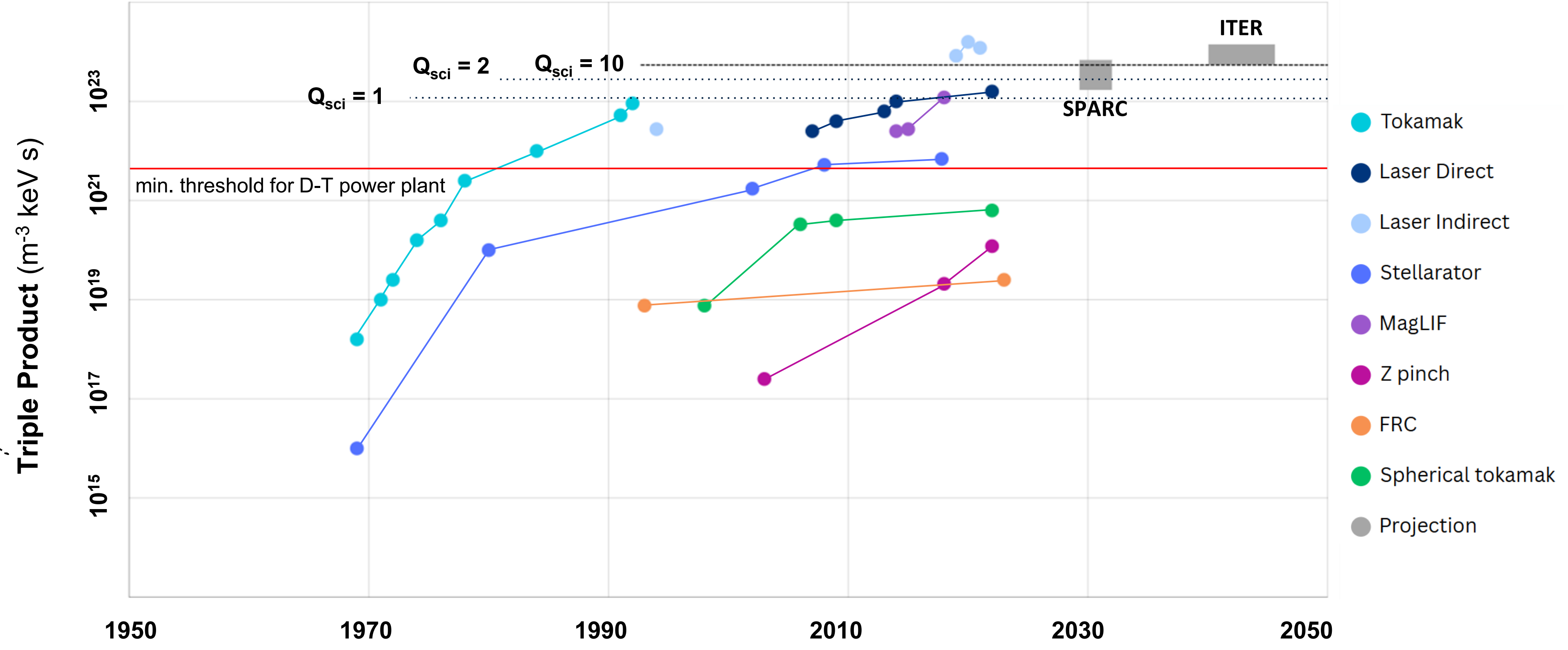
It is important to note that this energy gain is not the net energy gain in the entire process, but only the step where fusion occurs. For example, the **1.5x gain by NIF in 2023**, refers to fusion output vs. driver energy at fusion step only. The full system drew **~300 MJ** of electricity required to charge those lasers and other functions, generating **~3 MJ** of fusion, and **yielding just ~1% overall efficiency**. This clearly shows that we have a very long way ahead and there is need to devote more resources to fusion research, owing to the rapid advancements seen in ICF tech for the past 2-3 years.

Source: Fusion Energy Base. Note: Multiple data points for same year are because the demonstrations were made more than once.

Triple product to track the progress of fusion towards commercial

The plot shows the triple product values of various reactors and projects over the years, classified based on their fusion path

Obtained by multiplying three critical values – **plasma density**, **plasma temperature**, and **energy confinement time.** Higher value indicates fusion tech is closer to achieving the conditions necessary for a commercial power plant.



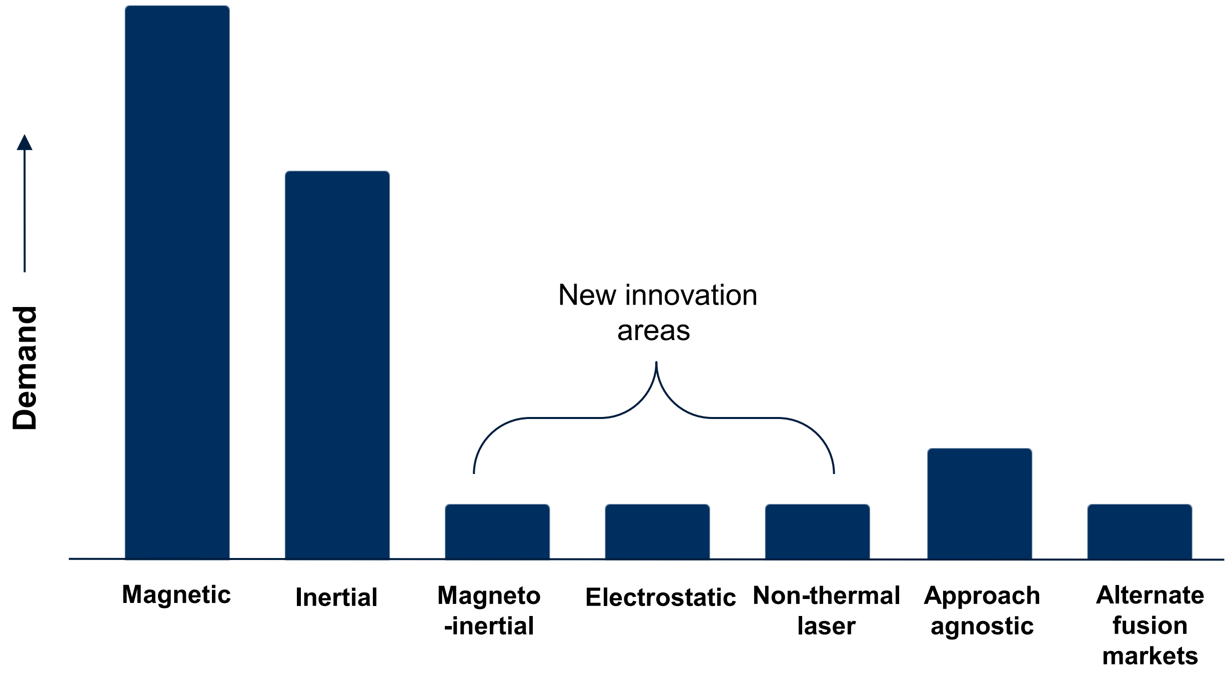
Although fusion experiments using **laser approach** have reached high triple product values, these were **not to the scale of commercial power plants**, so scaling is a significant challenge in these paths. Projects like ITER and SPARC are being developed at a commercial scale, and will achieve triple product values equivalent to Q_{engg}~0.5-1 by 2040 (≥15 required for commercial power generation). Projections suggest the triple product value required for **economic power plants** will be reached **by 2045** through advances in **magnets**, **breeding blankets** and **energy conversion systems**.

Source: Blume Analysis, Fusion Energy Base

Reliable supply of key components is vital for global fusion energy

There's a split between magnetically confined systems relying on superconducting magnets and inertially confined systems depending on laser components. Supply chains also contrast continuous-run reactors with pulsed systems demanding precise, high-frequency power control

Market demand for supply chain components based on technology type



- Startups pursuing novel fusion concepts must source specialized components and expertise, creating bottlenecks and uneven access
- Vendors of truly universal services – like design and engineering, vacuum systems, or control software – can plug into any fusion approach, enabling rapid growth and predictable demand
- MCF-specific parts and subsystems remain the hottest ticket in the supply chain

Over 70% of fusion-industry suppliers ramped up capacity in 2023 – adding facilities, advanced machinery, and workforce training – to serve today's customers and future demand. Investors can capture near term returns and secure critical strategic leverage by diversifying into these supplier plays.

Source: Fusion Industry Association

A robust supply chain is critical for achieving fusion at scale

Even though 77% of supply chain companies are investing in growing their capacities, several critical components are said to have current or future supply risks, signalling a need for long term certainty around financing and policy to build confidence in suppliers

Electronic components and systems: Capacitors, transistors, RF amplifiers, power supplies, spark gap switches

Magnetics: HTS magnets, magnets, cables, tapes; LTS magnets and cables, permanent magnets, resistive magnets, magnet cases

Cryogenic components and systems

Measurement systems: Microwave measurement, plasma diagnostics, spectrometers, equipment monitoring, fuel measurement

Fuel cycle: Integrated blanket solutions, targets, separation technologies, tritium storage and pumps, direct internal recycling, detritiation systems

Plasma Heating and thermal management: Gyrotrons, neutral beam generators, RF amplifiers, lasers, diverter solutions

Software: Materials design, data visualisation, simulation, design, control software

Supply risks exist in cryogenic devices, HTS wire, power electronics and vacuum chambers, as suppliers with alternative markets for these products need more confidence in fusion before making significant investments. While improving on this, innovation priorities should also focus on segments with less mature, but important technologies in the fusion supply chain. **Fuel cycle technologies**, **specialized electronic components** and **advanced software** are such areas where targeted innovation will help reach commercial stage faster.

Source: Blume Analysis, Fusion Energy Base

White spaces, scalable opportunities startups should eye for

Electronic Components and Systems

- Tokamaks face catastrophic disruptions that damage systems. **Power electronics that survive electromagnetic pulse like disruptions** with rapid response times are needed
- **Quantum control systems** for real time plasma optimization, with multivariable control support

Magnetics and Superconducting Systems

- **HTS materials achieving superconductivity at 50-77K** (liquid nitrogen temperatures; current ones at 30K) will dramatically reduce cooling costs. HTS tape production is a scalable business, each large reactor requires 500-1000 km of tape, with 100s of plants to be built
- **Plug and play magnet modules** for smaller fusion systems

Cryogenic Systems

- Current systems depend on increasingly scarce helium. Kronos Fusion Energy is pioneering hydrogen-based systems, but **helium-free cryogenics** remains a nascent field

Measurement Systems

- AI driven predictive analytics using ML to forecast plasma instabilities before they occur
- Real time, non-invasive monitoring systems for fuel (tritium) inventory management

Fuel Cycle and Target Systems

- Tritium recovery from legacy waste
- **D-D and p-B11 fuel cycles** avoid need of tritium, which is a very rare resource
- **Mass production of targets** (millions per month); and **injection systems** capable of speeds >1000m/s

Plasma Heating and Thermal Mgmt.

- Current ICF uses inefficient glass lasers. **Diode-pumped solid state lasers** could achieve 20-30% efficiency vs current 1-3%, but scaling to megajoule energies remains unsolved
- Improving **ion source design** beyond current 50% efficiency will cut auxiliary power demands sharply

Software and Digital

- Digital twins integrating plasma physics, structural mechanics, thermal hydraulics, and fuel cycle management
- Machine learning systems for predicting component failures and optimizing maintenance schedules

Source: Blume Analysis

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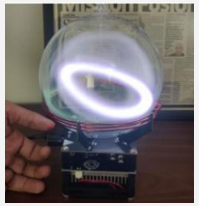
Indian Fusion Startups

founded in **2024**, it is **bootstrapped** currently, but has received a **grant from Startup India**

Pranos Fusion aims to build a Magnetic Confinement (MCF) based fusion reactor, which is the most invested and comparatively mature fusion path currently. They are working towards an evolved version of the popular Tokamak design – **spherical tokamaks**.



They have **reduced design iteration from 3 months to 10 days** and demonstrated small-scale plasma containment in a **desk size plasma globe**.

ANUBAL FUSION

founded in **2024**, by co-founder of **QNu Labs**, which focuses on quantum key distribution to enhance cybersecurity

Anubal Fusion is developing an Inertial Confinement Fusion (ICF) reactor, focusing on the fusion approach, currently closest to achieving net positive energy output.

Interim technologies like **Simulation software and Petawatt laser systems** are being developed by them to create more runway and also get scientific data and validation crucial for furthering the research and development. They have the technical expertise from TIFR Hyderabad and IIT Madras on their team.

HYLENR

founded in **2024**, it is **privately funded** and has received the **Aegis Graham Bell Award**, backed by govt. entities – MeitY, MoE, DST

Hylenr is developing an unconventional fusion method, energy through **Low Energy Nuclear Reactions** (LENR). These reactions are claimed to occur at room temperatures, without any harmful radiations and nuclear waste produced.

Source: Blume Research

Investment Insights

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Global focus shifted to fusion in 2021, to rise beyond $3bn in 2025

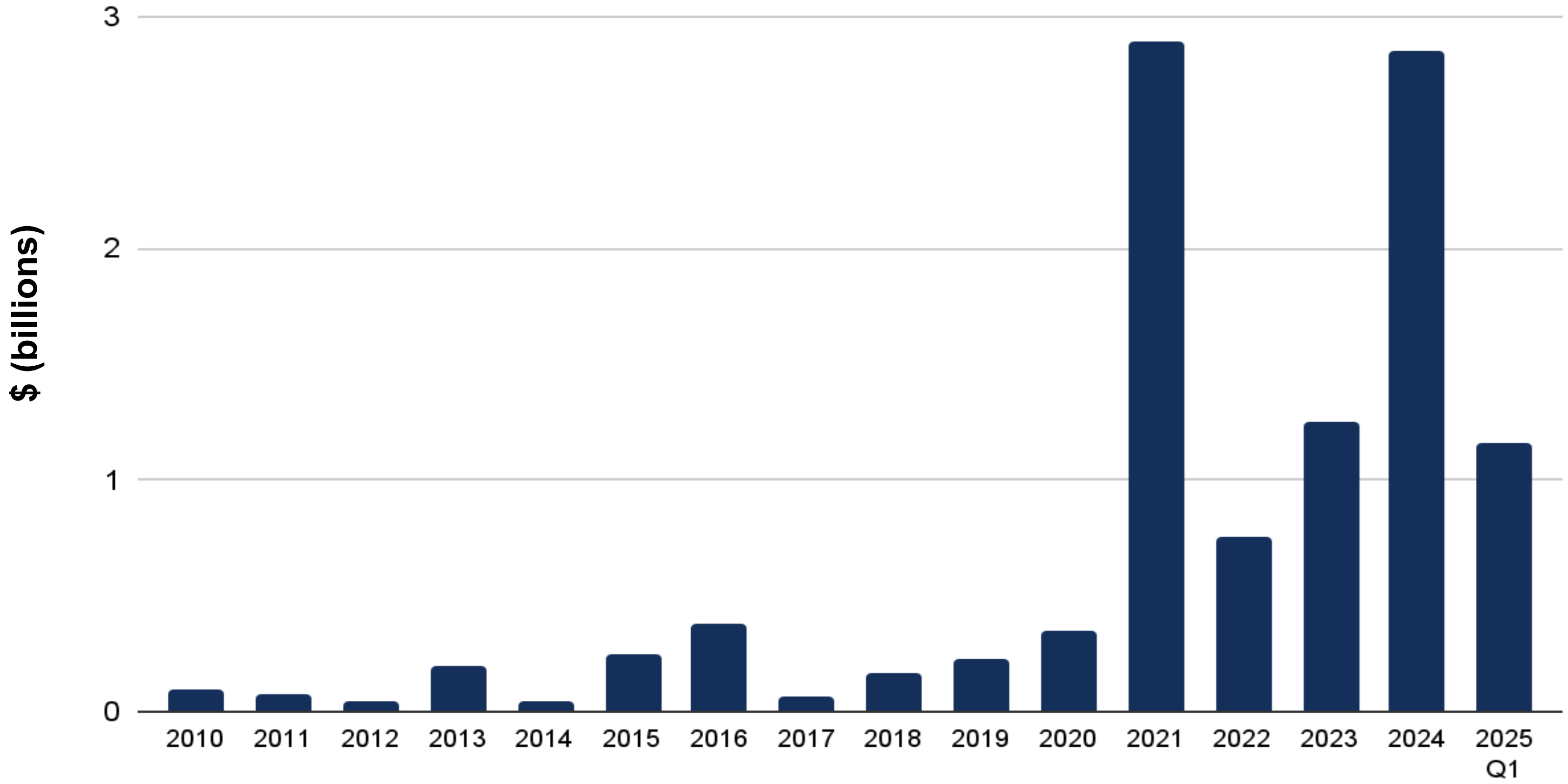
Low investments seen in 2022-23 are due to COVID19 pandemic, numbers bounced back to the high in 2024; First quarter in 2025 recording 1.16bn+

Global Equity Investments in Fusion Companies

Total Investments by Country

USA: **$6.33bn**
China: **$2.49bn**
UK: **$700m**
Canada: **$321m**
Germany: **$139m**
Japan: **$106m**
Israel: **$22m**
France: **$16.4m**
Sweden: **$8.4m**
Australia: **$3.6m**

Data based on the primary location of the fusion companies (upto 2024)



A 220% increase in the number of startups has been seen in the last 10 years, but investments have ramped up only recently, due to successful demonstrations by startups. Over 70% investments have gone to companies in the US, indicates talent and technological development in select countries

Source: Blume Analysis, Fusion Energy Base

Where to invest in nuclear?

0 → 30+ yrs

SMR Tech, Fusion Enabling Tech	Advanced Fission, Fusion Plants	Fusion Scale-Up, Hybrid Systems
• Gen III / IV Small Modular Reactors • Fuel supply chain including HALEU (current production at 20kg vs need of 40+ tons per year by 2030), and thorium tech • Modular construction tech, 3D printing of nuclear grade components, robotic welding systems, passive safety systems, AI driven predictive maintenance, reducing lead and downtimes of fission reactors • Fusion enablers ➞ HTS magnets, laser systems, optics, Plasma control, Helium-free cryogenics, digital twins, cybersecurity and quantum resistant encryption, etc.	• Supporting Gen IV+ fission tech ➞ MSR, FBR, HTGR, Micro reactors ➞ themes that align with India's nuclear programme • Tritium free fuel cycles (D-D, p-B11, etc.) • MCF through tokamaks, stellarators and advanced designs • ICF through laser injection, target manufacturing, efficient optics and power systems • Alternate fusion paths (FRC/MTF, Z-Pinch) • Pyroprocessing and waste recycling ➞ Waste-to-Value solutions • Specialized applications in process heat, medical isotopes, space and defense	• Grid scale fusion enabling tech including but not limited to Plant EPC, breeding blankets, first wall replacement, grid integration tech • Autonomous and predictive maintenance for fusion plants • Fusion-fission hybrids, enabling tech like subcritical waste burners doing water transmutation, Self sustaining fuel cycles using Li blankets, adv. isotope separation • Integrated reactors providing combined electricity, hydrogen, and industrial heat production from single facilities. • Direct energy conversion bypassing thermal cycles for greater efficiency (60-80% vs 35% currently)

Source: Blume Analysis

Meet our author

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Blume Ventures is among India's leading early-stage venture funds, investing in tech led ventures across sectors. We are presently investing out of our US $290m fund IV. We are sector agnostic investors and typically invest through Seed to Series A stages with a preference to come in early.

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Thank you!

While we are thesis driven, we are also open to questioning and changing our views as we learn from founders and the market. If you have any feedback on this thesis, or would like to push back on any view, please reach out!

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