

Brief for the Standing Committee on Environment and Sustainable Development Study on Clean Technologies

*General Fusion brief on support for transforming the
world's energy supply with clean, safe, and
abundant fusion energy*

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Please accept this brief in response to the Standing Committee of Environment and Sustainable Development's study of clean technologies being researched, manufactured, and utilized in Canada to reduce greenhouse gas emissions and reduce harms to the environment. The brief explains fusion energy technology, the history of our fusion energy company within Canada and our recommendations to the federal government. The same recommendations have been made within the federal pre-budget submission process and reinforced via letters of support from partners.

The Global Fusion Industry – A Race to Commercial Fusion

Fusion powers the sun and the stars, where the immense force of gravity compresses and heats hydrogen plasma, fusing it into helium and releasing enormous amounts of energy. Fusion energy on earth promises to fundamentally transform the energy landscape. A fusion power plant can be placed anywhere, powered by two isotopes of hydrogen and emitting no carbon or other greenhouse gases. Fusion is inherently safe, and with a radiation profile in line with medical-grade isotopes and no long-lived radioactive waste products, it can be regulated like hospitals or general industrial facilities. Fusion offers firm, on-demand baseload energy and secure access to clean energy with no geographical constraints, minimal land requirements, and broad siting and power application options.

Years of fusion technology development have paved the way for near-term fusion power commercialization. Three factors have influenced the advancement of fusion energy:

- Fusion science: Experts are increasingly able to model and understand the fundamental physics of fusion and, as a result, more properly control the behaviour of fusion plasma.
- Enabling technologies: Supercomputing and artificial intelligence, advanced composite materials, high-speed digital control systems, and additive manufacturing (3D printing) offer innovative new pathways to resolve historical barriers to practical fusion energy.
- Public and private investment: Building on decades of government-led research programs, \$5 billion USD has been invested over the past several years in private fusion companies with entrepreneurial, business-oriented approaches to commercializing fusion energy.

With these advances, the potential global fusion market is estimated to be \$1 trillion per year, and roughly 40 companies globally are participating in the race to commercial fusion power. Global investors and governments are making significant investments in fusion energy to capture the economic and environmental benefits of realistic, commercially-viable fusion power generation by the early 2030s.

The commercialization of fusion energy in this timeframe will require both political support and technical solutions to the historical barriers to practical fusion power generation—durability, fuel production, energy conversion and cost. General Fusion, a Canadian company with a two-decade history in British Columbia, has developed a unique, practical approach to fusion energy that solves these technical barriers. With sufficient government support for the Canadian fusion industry, Canada has a unique opportunity to secure a leadership position in the global fusion export market.

General Fusion - A Transformative Clean Energy Technology Company in Canada

Headquartered in Vancouver, B.C., General Fusion seeks to transform the global energy system with a uniquely practical fusion technology called Magnetized Target Fusion (MTF). From the beginning, General Fusion's MTF technology has been designed with commercialization for electricity production in mind. The technology is the fusion equivalent of a

diesel engine: practical, durable, and cost-effective. The approach uses refinements of existing technology, such as steam-powered pistons to compress plasma to fusion conditions, combined with transformative innovations, like a proprietary liquid metal wall, to make the machine durable and efficient. This approach addresses the four major challenges to commercial fusion energy, giving the Canadian fusion industry the opportunity to lead the global fusion market:

- Durable fusion machine: General Fusion's proprietary liquid metal wall compression technology absorbs neutrons and protects the machine from fusion damage, unlike other technologies.
- Sufficient fuel production: One component of General Fusion's fusion fuel is tritium. In General Fusion's MTF machine, sufficient tritium can be produced to sustain the fusion reaction. The liquid metal wall that surrounds and compresses fusion plasma contains lithium, which is transformed into tritium and helium by fusion neutrons.
- Simple energy conversion: In a commercial General Fusion power plant, hot liquid metal will be circulated from the fusion machine through a heat exchanger to boil water, producing steam that will drive a turbine and generate electricity. This is a fully industrialized process used in most modern power plants today, making General Fusion's approach suitable to repurpose traditional fossil-fueled power plants.
- Economical fusion conditions: Mechanical compression with liquid metal avoids the need for expensive magnets or targets, high-power lasers and exotic/unavailable materials required to sustain the fusion process in other technologies.

General Fusion aims to commercialize its technology by the early 2030s, leading to the deployment of fusion power plants across global energy markets and supporting a broad Canadian fusion energy supply chain.

The company's founder, Dr. Michel Laberge, started General Fusion on Bowen Island in 2002, and today General Fusion employs over 200 people in Canada. In the last several years, General Fusion has made significant technical progress at its lab in Vancouver and is now ready to demonstrate its technology at power-plant relevant scale.

Funding support from the Canadian Government under IRAP, SDTC and SIF has been critical to General Fusion's growth and success so far and has helped establish Canada as a significant player in the fusion clean energy industry. However, while General Fusion is now poised to move forward with its industry-leading demonstration program, IRAP and SDTC funds have run their course and SIF funding is set to expire in 2023. A new source of government support for the Canadian fusion industry is critical to sustaining Canada's leadership in clean fusion energy and continuing to support the industry's growth, including Canadian IP development, job creation and supply chain expansion.

To demonstrate its technology at scale, General Fusion's team in Vancouver designed a fusion demonstration that will be built at the U.K. Culham Centre for Fusion Energy. This demonstration will create fusion conditions, including reaching 100 million degrees Celsius in a power plant-relevant environment. This fusion demonstration is designed to confirm the performance and economics of General Fusion's technology, providing the information needed to design and build a commercial pilot plant that generates electricity at an affordable price.

This effort will require significant funding over the next five years from both private financing and government support. General Fusion is currently expanding its Canadian research lab to a 60,000 square foot facility at the Vancouver airport's Sea Island as a part of the YVR Innovation Corridor to support the technical workforce currently designing the demonstration machine and

facility. This workforce will be also critical to designing the world's first commercial fusion power pilot plant.

General Fusion's presence in Vancouver and business model offers significant economic benefits for Canada. The Canadian government's continued investment in fusion will support the growth of an industry poised to build and export this truly game-changing clean energy technology, ensuring that its workforce, intellectual property and supply base benefit Canada.

General Fusion has already begun building partnerships to support a stable and localized supply chain for future commercial power plants. The company is growing Canadian fusion expertise through partnerships with leading technical entities like the Canadian Nuclear Laboratory and Bruce Power. In addition, General Fusion's scientists in Vancouver have published a significant amount of peer reviewed studies, led international initiatives to share fusion-relevant coding and established over 30 technical and academic partnerships with the leading technical institutions such as MIT, Princeton and the U.K. Atomic Energy Authority.

In addition to employing applied scientists and engineers and generating significant Canadian intellectual property, General Fusion has the potential to serve as a powerful economic engine for the country by helping to build a Canadian fusion energy supply chain, from specialized steel production to large forging capabilities to advanced electronics.

Global Competition and Public and Private Investment in Fusion Energy

General Fusion is one of almost 40 companies globally participating in the race to commercial fusion power; it is one of only seven companies that have obtained more than \$200 million USD in private funding and is the only Canadian company on that short list.

In the past 2 years alone, private investment in fusion has increased by 163%, and global private investment in fusion now totals \$5 billion USD.¹ Private sector investments are building upon years of public investments, but governments remain key partners in fusion energy development as central guarantors of the public interest. In particular, the U.S. and U.K. governments are aggressively funding fusion energy development. The Canadian fusion industry is competing in this global race to reap the economic and environmental benefits of achieving commercial fusion energy.

The U.S. government has committed significant capital as well as policy and research resources to fusion. The U.S. currently spends more money on fusion than any other country in the world with \$600-700 million USD provided annually. In March 2022, the White House released its "Bold Decadal Vision for Fusion Energy" and the U.S. Department of Energy (DOE) has recently created fusion power plant programs authorized at greater than \$600 million USD that will deliver fusion power plant designs before the end of this decade. In September 2022, the DOE announced the first tranche of this program, with \$50 million for for-profit fusion companies, defining the program as a private-public partnership.² In addition to this new milestone program,

¹ The Global Fusion Industry Report, 2022. The Fusion Industry Association.

<https://www.fusionindustryassociation.org/post/the-global-fusion-industry-in-2022-report-in-the-news>

² "[Department of Energy Announces \\$50 Million for a Milestone-Based Fusion Development Program](#)," Office of Fusion Energy Sciences.

the U.S. Congress has provided \$713 million, a record high, for its Office of Fusion Energy Sciences.³

Similarly, the United Kingdom government is supporting ambitious fusion energy programs. The U.K. has established the STEP (Spherical Tokamak for Energy Production) program as an ambitious government-backed initiative to design and construct a prototype fusion power plant by 2040. Under this program, the United Kingdom Atomic Energy Authority received £222 million funding from the U.K. government to produce a commercial fusion plant concept design by 2024 and has recently identified the site for this future commercial fusion power plant. The U.K. government is also conducting a parliamentary probe into its nuclear power strategy, seeking input on how to better fund and accelerate the development of fusion energy⁴ and has recently established a regulatory framework for fusion that is similar to hospital regulations, providing regulatory certainty for the U.K. fusion market. As a part of its larger commitment to fusion, the U.K. government has also offered financial support to General Fusion to build its fusion demonstration at Culham.

Governments investing in fusion energy research and commercialization expect significant economic returns beyond the transformative decarbonization benefits of fusion. According to a 2020 study by London Economics, government investment in fusion research offers a fourfold return to the economy.^[5] The research looked at the financial and economic impacts of the U.K.'s public investments in the U.K. Atomic Energy Authority's (UKAEA's) fusion research from 2009-2019 and found that for every £1 invested in UKAEA, approximately £4 is generated in return. In addition, approximately 4,000 direct and indirect job years were created and there were significant advances to "fusion-adjacent" technologies" such as robotics, developments of new materials and contributions to computing and artificial intelligence. Other indirect benefits include the upskilling of the workforce through an improvement in skills and knowledge transfer. In sum, public investment in fusion energy research and commercialization offers a return that warrants further long-term, stable and large-scale public investments. As the industry moves toward broad commercialization, the opportunities for global clean energy exports and supply chain development are vast.

Global private and public investment in fusion is increasing as fusion technology progresses against the backdrop of global decarbonization efforts, the ongoing energy security crisis and rising electricity costs. Safe, carbon-free fusion energy power markets are developing worldwide. Now is the time for the Canadian fusion energy industry and the Canadian government to work together to secure Canada's leadership in clean fusion energy technology exports. Ensuring an adequate, predictable federal funding source for fusion and ensuring that fusion energy qualifies for all Canadian government clean energy and clean technology funding pools is critical to maintaining Canada's leadership in clean energy development.

To this end, General Fusion recommends that the government fund, on a level comparable to the United States and the United Kingdom, a Fusion Energy Fund initiated in FY 2023 to support the maturation of fusion technology, ensure the accelerated commercialization of

³ ["Congress Provides Record Funding for Fusion Energy and Initiates New Public Private Partnership,"](#) Fusion Industry Association.

⁴ "UK's Parliamentary Probe into the UK's Nuclear Power Strategy," [UK Parliament.](#)

^[5] "Government investment in fusion energy boosts British economy by £1.4 billion," UK Atomic Energy Authority (2020). Found at: <https://ccfe.ukaea.uk/government-investment-in-fusion-energy-boosts-british-economy-by-1-4-billion/>

Canadian fusion technology IP and secure Canada's leadership role in the advancement of fusion energy technology. The fund should guarantee long term, predictable funding over a five-year period.

With these points in mind, General Fusion recommends the Canadian government take the following actions in the FY 2023 federal budget:

Recommendation 1: Provide \$400 million CAD towards a Fusion Energy Fund initiated in FY 2023 that will support the maturation of fusion technology, ensure the accelerated commercialization of Canadian fusion-relevant IP and secure Canada's leadership role in the advancement of fusion energy technology. The fund should guarantee long-term, predictable funding over a five-year period.

Recommendation 2: Provide adequate funding for the Canadian Nuclear Safety Commission to support the development of commercial fusion power-plant regulations and the development, funding, and implementation of a public education campaign to be launched upon their release.

Recommendation 3: Establish a dedicated fusion policy group within the Energy Systems Sector at Natural Resources Canada to research and advise on the integration of fusion into Canada's electrical grid.