From Theory to Reality: The Limitless Potential of Fusion Energy

Statement for the Record – June 13, 2023

Chairman Williams, Ranking Member Bowman, members of the Committee – thank you for the invitation to testify before the Science Committee's Energy Subcommittee.

I'm Andrew Holland, CEO of the Fusion Industry Association, the voice of the private fusion industry. Our 37 member companies are the developers dedicated to building the energy system of tomorrow, on a timescale that is relevant to today's energy challenges. Our broader Affiliate Membership includes over 70 companies that will be a part of the broader fusion energy economy.

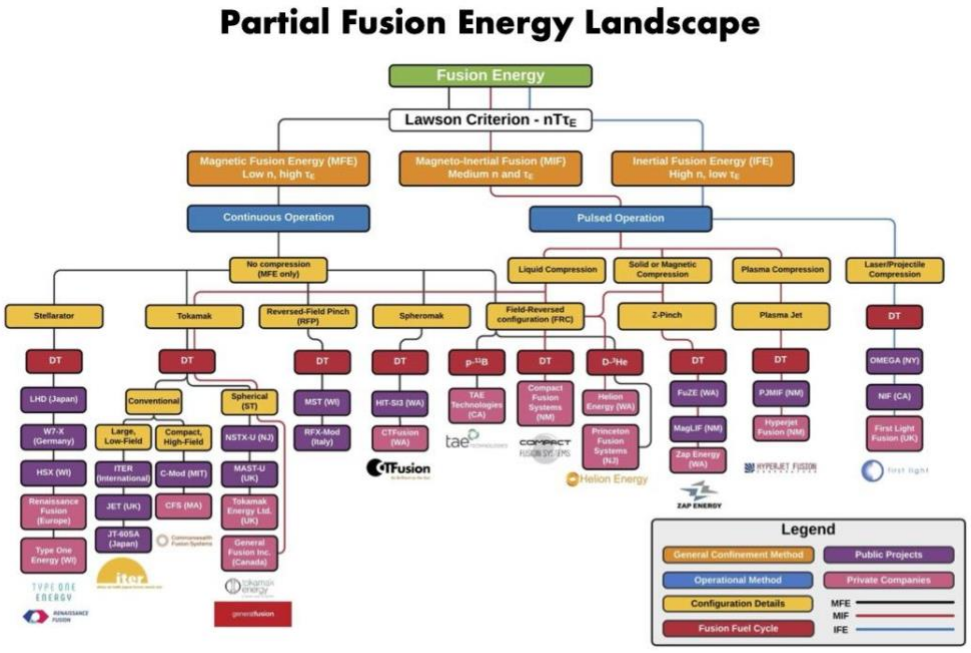
Unlike my colleagues on this panel, I'm not a scientist. Instead, my background is in politics and policy – I started my career answering phones for a Member of Congress a few hundred yards away from here. And that's appropriate, because the FIA supports our member companies in building the policy, regulatory, and economic case for fusion energy – everything that has nothing to do with the engineering of a fusion power plant or the complicated physics of plasma confinement.

I'm excited to be here testifying because fusion can solve so many of our problems. Of course, fusion is a clean energy solution: it will be zero-carbon energy that is always available, with no long-lived waste and no chance of a meltdown. It will also be the most compact and efficient energy source available: one pound of fusion fuel would yield the same energy as 10 million pounds of coal. That means that fusion can scale – when fusion power plants are widely available, we'll be able to bring energy abundance to areas of the country and the world left behind. Finally, the links between energy and national security have never been clearer after Russia's illegal invasion of Ukraine. Deploying fusion would mean that geography no longer matters for energy availability: no dictator could block imports of a fusion power plant.

When you put all these benefits together, it is clear why there is bipartisan interest in commercializing fusion energy. And that might be one of the most important parts of fusion: across a divided Congress, I have seen no evidence of a partisan divide. Likewise, while the Biden Administration has a "Bold Decadal Vision" for commercial fusion, much of the groundwork for today's policy was laid by the Trump Administration's Department of Energy – along with bipartisan leadership in this Committee. I give specific commendation to the Membership of this Committee which has worked together over many years to advance fusion energy research and development.

Now, let me give you some statistics and details about the growth of the private fusion industry. Until just a few years ago, fusion energy research was almost entirely publicly funded in national labs or universities. Today, there are more than 40 fusion companies around the world with over five and a half billion dollars invested in them. When this Committee last held a hearing on fusion energy in November 2021, less than half as much was invested and more than a third of the FIA Membership had not yet been founded.

Fusion companies span the full range of technological approaches to fusion, with multiple concepts for laser inertial fusion at one end to magnetically confined fusion at the other, and many "magneto-inertial" approaches that take elements from each. This diversity extends to different proposed fuel sources – including isotopes of hydrogen, boron, or helium – and aiming for a range of power plant sizes. Most are aiming to build electricity generating power plants, but others are aiming for process heat, space propulsion, or marine applications. You can see a "Family Tree" of fusion that gives some idea of the diversity.[1]



That diversity itself is a means of managing risk: 37 "shots on goal" give us more chances of scoring than concentrating resources on just one approach. We shouldn't expect there will be only one winner. Just like there's a diversity of global automotive manufacturers focused on different styles and markets, perhaps there will be a diversity of fusion power companies as well.

[1] Derek Sutherland, Ph.D. "Partial Fusion Energy Landscape" Fusion Regulatory Public Forum, slide 26. January 26, 2021. https://www.nrc.gov/docs/ML2102/ML21026A315.pdf

Although fusion firms are aiming to alleviate the global problems I mentioned earlier, the industry is not a charity, of course. Fusion companies share the goal of making money by selling a product. Investing in fusion research has beneficial results beyond the ultimate goal of clean fusion energy. These include key national security, health, and clean energy applications. We have member companies that have spun-off subsidiaries tackling major issues – and finding new revenues. New industries always catalyze new businesses – fusion is no different.

For everyone in fusion, there's always one question: "WHEN?" And we all know the bad joke about how long fusion takes. Technological breakthroughs are a function of both time AND resources. Fusion has not met its time goals because the necessary resources were never applied to it. Today, the addition of private funding, commercial innovation, and new public-private partnerships mean that fusion is on an accelerated pathway to commercialization.

Last year, the White House hosted a summit on fusion energy, initiating a "Decadal Vision" for commercial fusion. FIA members agree that this timeline can be achieved. In a survey, over 90% of fusion companies expect to see fusion electricity on the grid in the 2030s or before, with most expecting to see it in the first half of that decade.[2]

Let me be clear, this is extremely ambitious, and requires focus on hitting mid-term milestones, parallel pathways, new partnerships, and more resources. Today, multiple companies are building their "Proof of concept" machines that will prove that fusion can be a viable energy source. As new funding rounds are announced, more will start down this pathway. Then, they will swiftly move to designing and building the pilot plants that will demonstrate energy production. These pilot plants – defined well in a 2021 National Academies Report "Bringing Fusion to the U.S. Grid" – will prove that fusion can be a commercial venture.[3]

The FIA's report on the fusion energy supply chain, which we published last month, gives a sense of the scale needed as we grow towards pilot plants. Last year, fusion companies spent over $500 million dollars on their supply chain, but that will grow to over $7 billion dollars per year as they build those pilot plants.[4] These figures are not just money – they represent a growing workforce and new technological innovation.

Fortunately, there are fewer barriers to scale in fusion than the sort we're accustomed to in other fields of energy. Fusion fuel obviously doesn't face the same restrictions that fossil fuels do. But nor does fusion rely on significant quantities of rare-earth elements or other resources that could be constrained. Instead, fusion energy relies primarily on specialized manufactured products. Some of these specialized products, like power semiconductors, are currently

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[2] Fusion Industry Association. 2022. *The Global Fusion Industry in 2022.* Washington, DC. https://www.fusionindustryassociation.org/fusion-industry-reports/.

[3] National Academies of Sciences, Engineering, and Medicine. 2021. *Bringing Fusion to the U.S. Grid*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25991.

[4] Fusion Industry Association. 2023. *The Fusion Industry Supply Chain: Opportunities and challenges*. Washington, DC. https://www.fusionindustryassociation.org/fusion-industry-reports/.

constrained in the global marketplace. As Congress considers new legislation to address gaps in the manufacturing supply chain, efforts to build domestic manufacturing of critical parts within the fusion supply chain should not be left out.

The ultimate goal of the fusion companies is not to get to a single pilot plant putting electricity on the grid, but to build an industry that can *scale* in the years afterwards.

Globally, American-located firms have an early advantage in the private fusion landscape, with about 80% of the private funding invested in American firms, and 23 of the 37 current FIA members were founded in the US. A large portion of the others have established subsidiaries in the US for partnerships and research. The combination of investors familiar with risk and deep tech, entrepreneurial scientific culture, and increasing partnership with the government should make the U.S. a global leader.

However, in the last year, other countries have moved forward their plans for commercial fusion, with Japan, South Korea, and Germany most recently updating their plans. The United Kingdom probably has the most ambitious program, and I can attest that virtually every major fusion company has toured their facilities near Oxford to discuss siting and partnership options. The European Union, which hosts ITER and has invested the largest share of capital into its development, has a large research and commercial program in support. Only recently, though, has there been an indication that they are ready to invest in an innovative private sector fusion program.

While American allies and partners race towards fusion, China is also making key investments and hitting important milestones. The Chinese program is nearing completion of what they call CRAFT (Comprehensive Research Facilities for Fusion Technology), a facility that will provide materials research and testing systems for fusion energy. They already have one of the leading fusion research facilities in the world at EAST (Experimental Advanced Superconducting Tokamak), an experiment that has broken records for plasma confinement time and temperatures.[5] CRAFT will confirm their national program with more advanced facilities than anything available in the United States.

There have also been significant investments equivalent to hundreds of millions of dollars into private fusion firms in China, though it's not clear how separate they are from the public program. If China wins the race to fusion energy, I'm sure there will be many more Congressional hearings examining how that happened.

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[5] Jinxing Zheng, Jinggang Qin, Kun Lu, Min Xu, Xuru Duan, Guosheng Xu, Jiansheng Hu, Xianzu Gong, Qing Zang, Zhihong Liu, Liang Wang, Rui Ding, Jiming Chen, Pengyuan Li, Lei Xue, Lijun Cai, Yuntao Song, *Recent progress in Chinese fusion research based on superconducting tokamak configuration,* The Innovation, Volume 3, Issue 4, 2022, ISSN 2666-6758, https://doi.org/10.1016/j.xinn.2022.100269.

Perhaps the best question, then, is not "When" will we see fusion, but "Where?" If the United States does not provide an attractive policy environment for fusion, private companies will locate elsewhere, or China will seize a lead with its home-grown approaches.

So, what is to be done? The policy options for building the fusion energy revolution amount to three key buckets: deployment, regulation, and partnerships.

The first two are outside the jurisdiction of this committee, so just a brief word on them to say that fusion requires policy and regulatory certainty – investors are making large technology bets, so the government should not add to their uncertainty. The FIA supports technology-neutral incentives like those passed in last year's Inflation Reduction Act and will continue to advocate for a level playing field alongside other clean energy sources. The FIA supports the decision by the NRC earlier this year to separate the regulation of fusion energy from nuclear fission; a critical step towards building a regulatory environment that supports innovation while protecting public safety and security.

On the third area, partnerships, I want to give credit to this committee for the efforts to build public-private partnerships. And we're finally seeing them implemented: the announcement two weeks ago of $46 million dollars in new milestone-based awards to eight fusion energy companies – all members of the FIA – is just the start. This program, loosely based on the NASA program that invested in commercial space, will use public dollars to incentivize private investment through a program that focuses on meeting milestones – a "pay for performance" program. This $46 million is spread across eight different technologies and is leveraged far more than 50%. But getting to fusion pilot plants will require a larger program: Congress has authorized it up to $415 million dollars over five years, but in just these eight partnerships, it would take $2 billion dollars in federal cost-share to meet the goals.

But we make a mistake if we think of public-private partnerships as just one program. Instead, we need the Department of Energy, national labs, universities, and communities to become full partners in the efforts to commercialize fusion energy. The Milestone Program's focus on community engagement and energy justice is a way to ensure that fusion's benefits will flow across society from the start.

Because the private sector has come to the table with such significant stakes, the federal budget outlays for the transformative potential of fusion are less than a need for a "Manhattan Project" type of outlay – but they're not nothing. This year, for the first time, the Biden Administration requested over $1 billion dollars for fusion energy research and development. The budget specifically included $276 million in what they called "U.S. Fusion Program Acceleration" – funding for the milestone program and four new four multi-institutional, multi-disciplinary Fusion R&D Centers that will support efforts to build pilot plants, including on (1) Blanket and Fuel Cycles, (2) Advanced Simulations, (3) Structural and Plasma Facing Materials, and (4) Enabling Technologies.

The FIA and the whole fusion community united in supporting this request. A bipartisan group of 55 Members of the House of Representatives sent a letter in support of this funding request.[6] Thanks to the tireless effort of the leaders of this Committee, in passing the Energy Policy Act of 2020 and the CHIPS and Sciences Act of 2022, we have a policy framework that enables a move towards fusion commercialization.

Congress must assert its oversight responsibility to make sure that the Department of Energy is ready to rapidly implement these programs - and then Congress must also make the appropriations necessary to meet the moment.

Let me close by saying that this is exactly how the United States works best: public leadership on science and infrastructure paired with private capital and innovation. In 2050, when they write the book on how fusion was commercialized, what role will Congress have played? The opportunity is there for you to seize it.

[6]Letter to Chairman Fleischmann and Ranking Member Kaptur, "To express strong support for the fusion energy and plasma science research programs funded by the Office of Fusion Energy Sciences (FES) within the Department of Energy's Office of Science." March 31, 2023 https://drive.google.com/file/d/1yLyTYO84oLG6-3-XJBSvZvqXjYyNsDGu/view