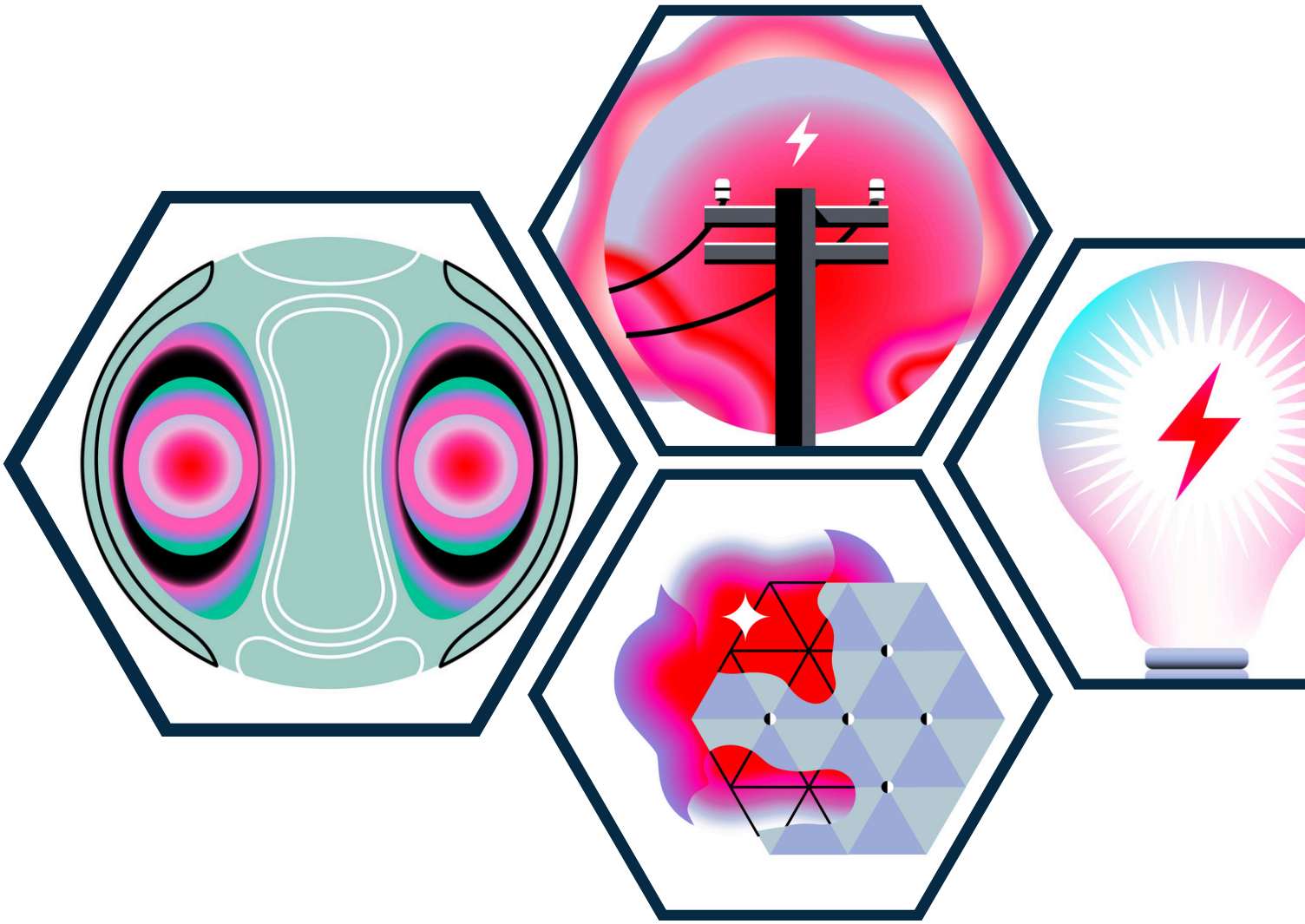
Fusion Energy Strategy 2024



U.S. DEPARTMENT OF ENERGY

Introduction

Fusion can potentially provide a safe, abundant, zero-carbon-emitting source of reliable primary energy. Over the past decade, the landscape around fusion energy research and development (R&D) has evolved significantly, especially in the United States. Building on decades of public investments in fusion science and technology (S&T), major advances are being achieved domestically and globally by public- and private-sector entities, such as the achievement of fusion ignition. These are indications of fusion's increasing technical readiness. Other major advances, e.g. in high-temperature superconductors, advanced materials, and artificial intelligence, have the potential to further accelerate and transform fusion R&D.

The more than $6 billion of cumulative equity investments into private fusion companies, with 80% of these investments into United States fusion companies, is an indication of fusion's potential upside as a future commercial energy technology. While the shift toward greater private-sector involvement in fusion R&D is seen most dramatically in the United States, it is a strongly growing global trend with equity investments in companies based in Canada, U.K., Japan, E.U., China, and others. Fusion has become a global race.

Recognizing this changing landscape and new opportunities for partnerships with the growing fusion private sector, in March 2022, the White House Office of Science and Technology Policy (OSTP) and the Department of Energy (DOE) co-hosted the first-ever White House Fusion Summit on Developing a Bold Decadal Vision for Commercial Fusion Energy. The Bold Decadal Vision represents a policy shift in U.S. fusion energy R&D to accelerate the viability of commercial fusion energy, while continuing to advance its scientific and technological foundations.

Guided by the 2021 National Academies report Bringing Fusion to the U.S. Grid and informed by the 2020 DOE Fusion Energy Sciences Advisory Committee (FESAC) Long-Range Plan (LRP), the Bold Decadal Vision aims to leverage public-private partnerships (PPPs) to:

- Accelerate fusion energy R&D to enable commercially relevant fusion pilot plants.[1]
- Demonstrate an operating fusion pilot plant, led by the private sector, in the 2030s.
- Prepare the path to enable aggressive commercial fusion deployment scale-up.
- Ensure that fusion energy is developed and deployed equitably, stimulating economic development across diverse communities.

For Superscript Footnotes Refer to pg. 25

At the 2022 White House Fusion Summit, Secretary of Energy Jennifer Granholm announced that the DOE would launch a department-wide initiative to support the Bold Decadal Vision and develop a decadal strategy for accelerating the viability of commercial fusion energy in partnership with the private sector. The DOE's decadal fusion strategy is organized into three pillars, as illustrated in Fig. 1, with the following high-level objectives:

1. Close the S&T gaps to a commercially relevant fusion pilot plant.

2. Prepare the path to sustainable, equitable commercial fusion deployment.

3. Build and leverage external partnerships.

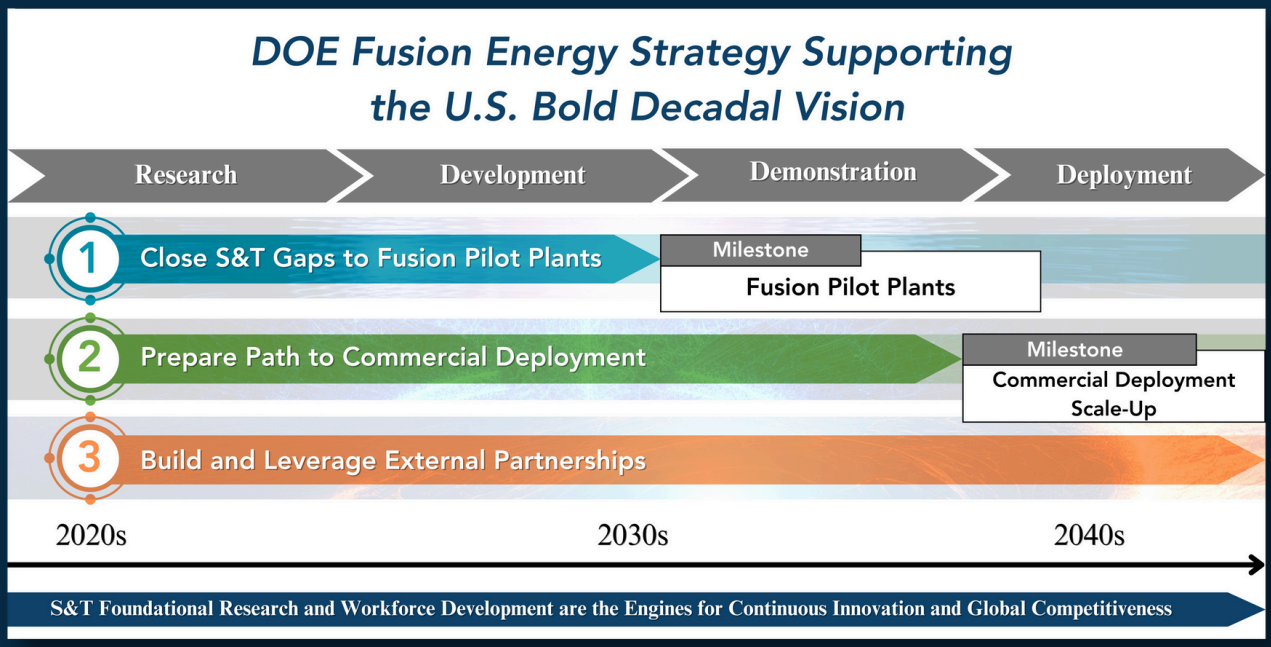


Figure 1. The three pillars of the DOE fusion strategy in support of the Bold Decadal Vision, shown with aspirational timeline that is strongly dependent on the level of both public and private investments.

STRATEGY PILLAR 1:
Closing S&T Gaps to a Fusion Pilot Plant

This pillar is focused on closing S&T gaps to enable private-sector-led and government-enabled demonstration(s) of one or more commercially relevant fusion pilot plants. The pillar is led by the DOE Office of Science (SC), through its Fusion Energy Sciences (FES) program. SC has the statutory authority[2] and appropriated funding to carry out a "fusion energy sciences research and enabling technologies development program to effectively address the scientific and engineering challenges to building a cost-competitive fusion power plant and to support the development of a competitive fusion power industry in the United States."

This pillar will be pursued with the following actions:

- **Realigning the SC FES Program to support the Bold Decadal Vision and a new SC FES vision**
- **Developing and following a new national fusion S&T roadmap that is aligned with the U.S. fusion industry**
- **Accelerating R&D by leveraging:**
  - **Alignment with industry: innovative PPPs for realizing fusion-pilot-plant designs, timely delivery of strategic fusion R&D test facilities, and catalyzing broader partnerships**
  - **S&T push: new FIRE (Fusion Innovation Research Engine) Collaboratives, which are underpinned by a realigned SC FES program**
  - **Research and capabilities across other DOE and National Nuclear Security Administration (NNSA) programs, as well as those of strategic international partners.**

Realigning the DOE Fusion Energy Sciences Program

The SC FES program will be realigned to support the Bold Decadal Vision and a new SC FES vision entitled Building Bridges, announced in December 2023. The new vision will focus on aggressively closing the S&T gaps needed to realize commercial fusion energy in the three key S&T areas identified and described further in the FESAC LRP: Sustain a Burning Plasma, Engineer for Extreme Conditions, and Harness Fusion Power.

Vision

The new vision will shift the balance of research toward fusion materials and technology, for example, by establishing new programs and redefining existing ones as discussed further below. Supporting both this pillar and to lay a foundation for future demonstration and deployment, three key elements of the new SC FES vision are:

- **Workforce development: establish sustainable and resilient pathways for diverse and exceptional talent**
- **Bridging gaps: creating innovation engines with national laboratories, universities, and industry to resolve S&T gaps and stimulate domestic supply chains for fusion energy**
- **Transformational science: nurture plasma science and technology discovery translating to innovation impact**

To inform the SC FES program realignment, two FESAC charges in 2024 will (1) assess SC FES program elements and their alignment with the LRP and Bold Decadal Vision, and (2) prioritize new or upgraded R&D facilities that will best serve the needs of the program over the next decade.

To support the realigned SC FES program and to build bridges across all three pillars, SC FES has established a new division named Enabling Science and Partnerships (ESP).

This division will identify resources and R&D synergies, and bring expertise, to support partnerships with other DOE programs and equities, including laying the groundwork for a future transition to demonstration and deployment activities.

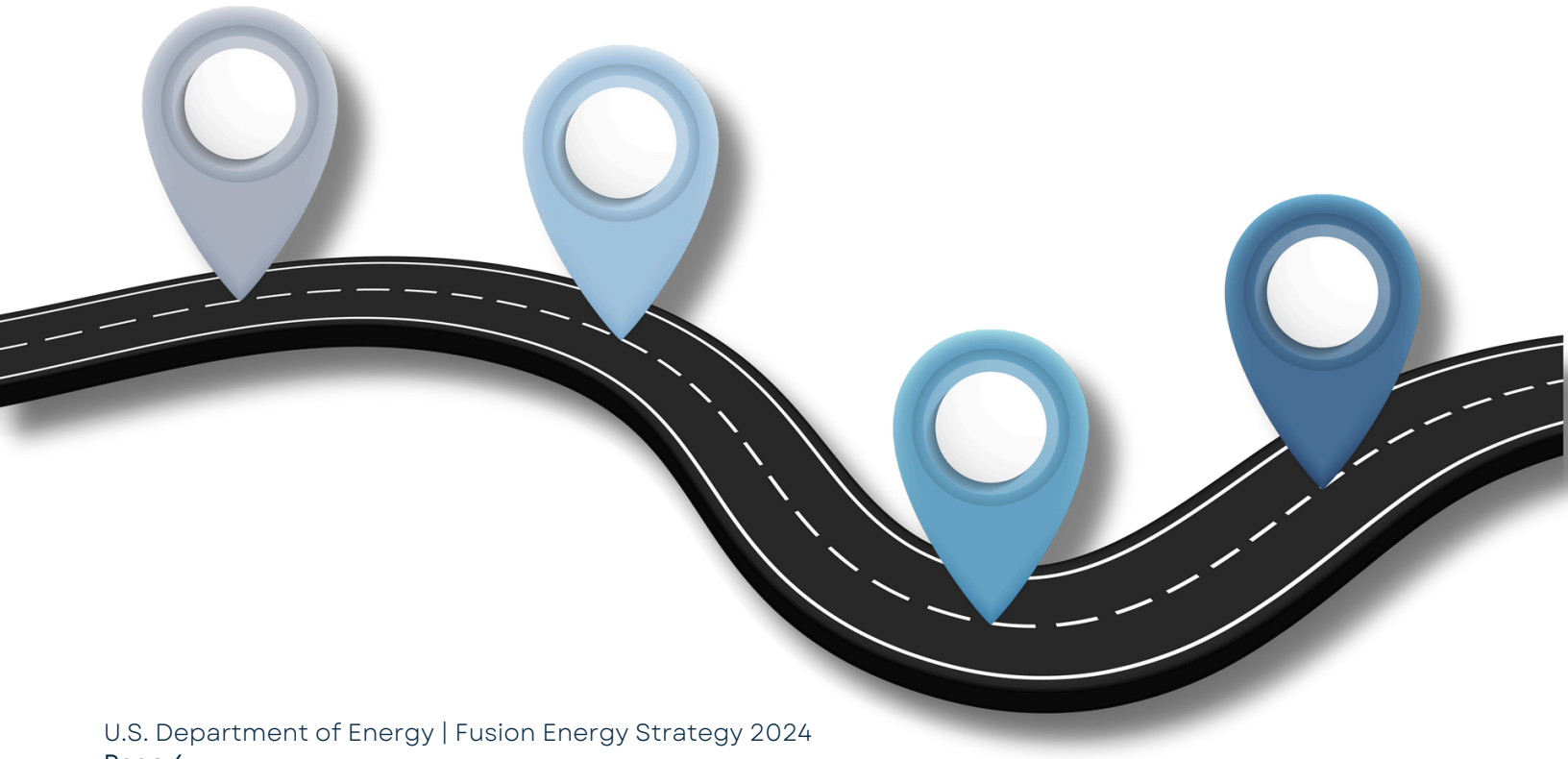
The new division will catalyze further growth of the public and private fusion ecosystem and support workforce development and community engagements. The latter will help identify public concerns about fusion such that the concerns can be addressed at the R&D stage.

Development of a National Fusion S&T Roadmap Aligned with Industry

SC FES will develop a metrics-driven national fusion S&T roadmap that informs decision-making on the “how” and “when” (including facility needs) of closing the critical S&T gaps.

The roadmap, to be released in 2025, is being developed in part based on output from a series of community workshops from 2022–2024 on several critical areas, including public-private partnerships in fusion energy R&D; inertial fusion energy; updating the requirements for a fusion prototypic neutron source (FPNS); fusion neutronics; magnet technology; fuel cycle and blankets; fusion materials; measurement innovation; and fusion workforce development.

The roadmap will be unique in the world by being aligned with the fusion industry and ensuring that SC FES is guided by innovation principles bridging foundational research with user-inspired and user-defined goals.



Leveraging Public-Private Partnerships

Public Private Partnerships (PPPs) will be employed as a key enabler of the DOE fusion strategy. Benefits of PPPs include better leveraging by the private sector of the expertise and capabilities in the public sector; greater available financial resources to achieve objectives and accelerated timelines; alignment of stakeholder incentives by sharing costs; and R&D being pursued in a way that is relevant and valuable for commercialization. Examples of recent and ongoing fusion PPP programs include the ARPA-E fusion capability teams, the SC FES Innovation Network for Fusion Energy (INFUSE), and the SC FES Milestone-Based Fusion Development Program ("Milestone Program").[3,4]

Examples of new innovative PPP models[5] could include but are not limited to programs to advance foundational science and enabling fusion R&D on private facilities or a public-private consortium framework (PPCF) anchored by regional hubs. Complementary to the Milestone Program and FIRE Collaboratives (discussed further below), a PPCF would amplify federal funding by catalyzing and bringing together state/local government, private, and philanthropic funding to resolve significant, remaining S&T gaps (with an emphasis on precompetitive R&D and aligned with technology roadmaps of private-sector fusion developers and critical supply-chain providers) and to deliver essential small-to-medium scale R&D test facilities.

The envisioned regional hubs would stimulate development of fusion supply chains and workforce, while also supporting regional economic development and community engagements. The DOE Foundation for Energy Security and Innovation (FESI) could be a potential vehicle for convening non-Federal partners and launching a fusion PPCF.

Bridging Gaps Through the FIRE Collaboratives

To resolve S&T gaps to a commercially relevant, private sector-led fusion pilot plant and to support the creation of a fusion innovation ecosystem, the new SC FES FIRE (Fusion Innovation Research Engine) Collaboratives program will consist of virtual, centrally managed teams called "Collaboratives," which can be led by all types of domestic applicants including DOE/NNSA national laboratories, universities, non-profits, and private companies. This program bridges SC FES's foundational and enabling S&T research programs to the work and needs of the growing fusion industry. Moreover, this initiative aims to create new economic opportunities, bolster U.S.-based manufacturing and supply chains, and enable the development of technologies that are also crucial for national security, defense, and other commercial industries.

Leveraging Expertise and Capabilities Across the DOE, NNSA, and International Partners

Synergistic equities and capabilities across other DOE and NNSA program offices will be leveraged to help close the S&T gaps to a commercially relevant fusion pilot plant. In nearly all these cases, the other programs do not have a fusion-energy-development mission, but they do support R&D, capabilities/expertise, and/or facilities in highly relevant, overlapping S&T areas. Examples include but are not limited to materials in extreme conditions, inertial and magneto-inertial fusion, other/emerging fusion concepts, advanced simulation including exascale computing and artificial intelligence, and tritium/isotope technologies.

In some cases, the synergistic equities include S&T areas that support the needs of eventual fusion deployment scale-up rather than the technical viability of a fusion pilot plant itself, such as isotope production, “security by design,” accident analysis, waste management, advanced manufacturing, etc. These latter examples are included in the second pillar of the fusion strategy. Synergistic equities and capabilities of strategic international partners of relevance to both pillars 1 and 2 will be leveraged as well.

Further details on SC FES realignment, the national fusion S&T roadmap, potential new PPP programs, and metrics/timelines against which DOE will measure fusion activities, will be released in the coming months.

STRATEGY PILLAR 2: Preparing the Path to Commercial Fusion Deployment

The ambitious, aspirational timeline of the Bold Decadal Vision to realize a commercially relevant, private sector-led fusion pilot plant in the 2030s, followed by commercial fusion deployment scale-up throughout the 2040s, requires broader activities to be pursued in parallel with resolving the S&T gaps for a fusion pilot plant. These activities are systematically laid out as part of the DOE Adoption Readiness Level (ARL) framework, which was created by the Office of Technology Transitions (OTT) to guide technologies across the commercialization continuum, i.e., research, development, demonstration, and deployment (RDD&D). Figure 2 illustrates commercialization risks that fusion energy will face on the road to commercial deployment. Several risk areas can and should be addressed by DOE starting today.

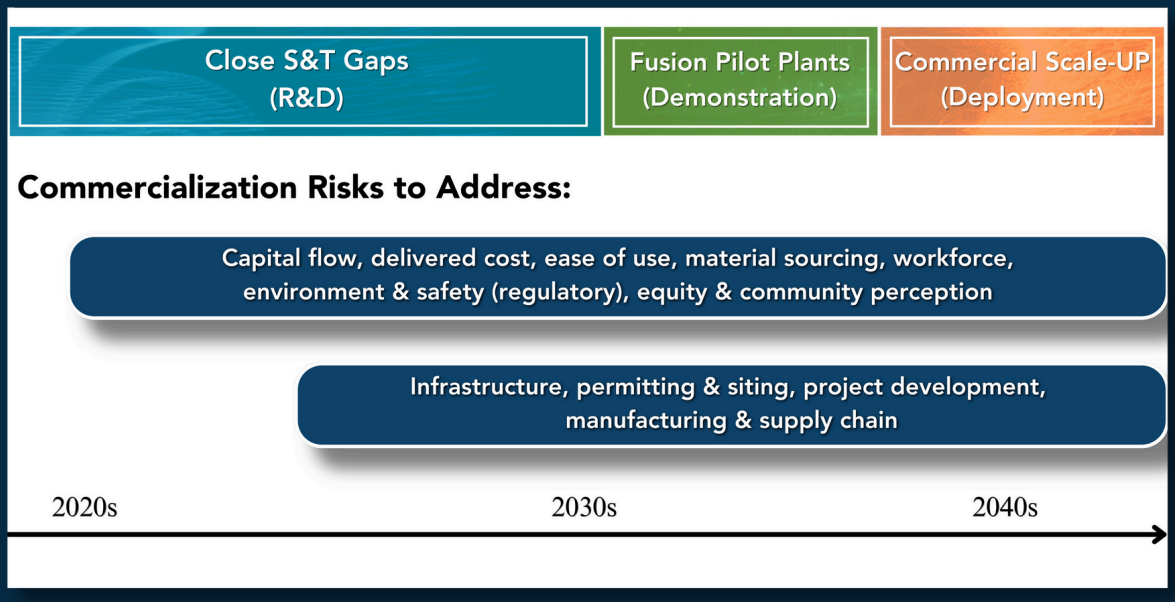


Figure 2. Commercialization risks for fusion, based on the ARL framework, highlighting those with long lead times that are starting to be addressed today. The aspirational timeline as shown is strongly dependent on the level of both public and private investments.

The work of this pillar is presently coordinated by the Fusion Crosscut Team (FCT), which is led by the DOE Lead Fusion Coordinator in the Office of the Under Secretary for Science and Innovation and co-chaired by the SC Associate Director for FES. The FCT was formed in June 2022 following the White House Fusion Summit. The FCT coordinates fusion-relevant activities across DOE equities and programs (Fig. 3).

Building and expanding upon ARPA-E's fusion technology-to-market (T2M) efforts since 2015, which has focused on stimulating the growth of private fusion investments and the overall public-private fusion ecosystem, the FCT will continue to coordinate efforts across the DOE to support the path to commercial fusion deployment. Inclusion of OTT on the FCT will help ensure that the overall DOE fusion strategy leans into and benefits from all the technology-maturation and partnership mechanisms and tools available to DOE to accelerate the RDD&D lifecycle toward realizing the Bold Decadal Vision and ultimately a world-leading and vibrant U.S. fusion industry.

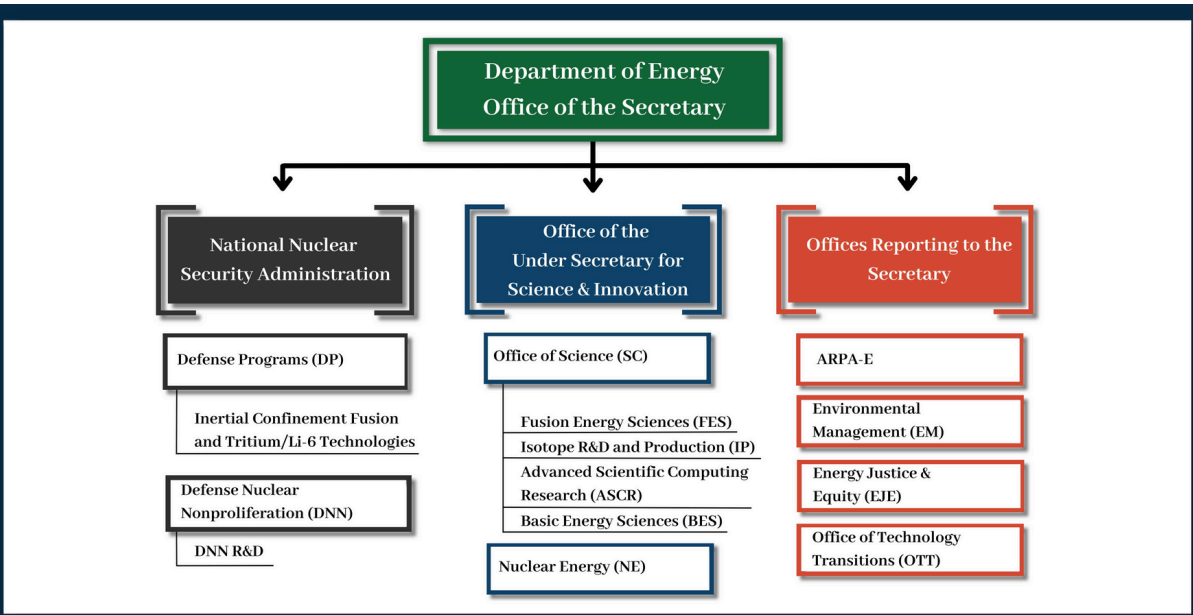


Figure 3. DOE equities with representation on the Fusion Crosscut Team (as of June 2024).

DOE will build on activities[6] that the FCT has already initiated in support of the Bold Decadal Vision's ambitious goals. These activities are a subset of the dimensions of the ARL framework that are appropriate to start addressing at this stage of fusion energy development. Some of these activities (listed with their ARL dimension) are described further below.

Example of Commercialization Risk Starting to Be Addressed (Capital Flow)

Innovative Public-Private Partnerships

The significant private capital being invested into fusion energy R&D was a key factor in launching the Bold Decadal Vision, which emphasizes PPPs as a way to accelerate the timeline for fusion energy RDD&D. However, significantly more capital, from both public and private sources, will be needed to realize the Bold Decadal Vision.

The strategy to attaining the required capital flows are embodied throughout all three pillars of the DOE fusion strategy. In the first pillar, this includes alignment of public and private efforts in fusion R&D as well as executing innovative PPP programs (e.g., the Milestone Program) that catalyze greater private investments and broader partnerships.

In this second pillar, addressing long-lead-time needs (as identified in the ARL framework) signals government commitment to timely fusion commercialization. This helps instill investor and developer confidence. Building and leveraging broad partnerships, discussed further in the third pillar, will help directly with capital flow and making optimum use of the available capital (including accessing key infrastructure).

Example of a Commercialization Risk Starting to Be Addressed (Materials Sourcing)

Isotope Fuel Supplies

Fusion uses light isotopes as its fuel, such as deuterium, tritium (isotopes of hydrogen), helium-3, and boron-11. Because tritium is not naturally available in meaningful quantities, sustainable commercial fusion energy based on deuterium and tritium (D-T) requires generating (i.e., "breeding") tritium from lithium-6, which is therefore also required for D-T fusion plants. While each D-T fusion plant is envisioned to breed tritium continuously to sustain its own tritium supply, each plant also requires a certain amount of startup tritium and lithium-6. A sustainable supply of helium-3 would be required for fusion approaches using deuterium and helium-3 (D-^{3}He).

In 2023, DOE SC IP and SC FES completed an initial high-level assessment of the potential demand for these enriched light isotopes at the fusion demonstration and deployment scale-up phases, based on fusion-industry projections. Determining the needed quantities and enrichment levels of light isotopes for the first fusion pilot plant, as well as for commercial deployment scale-up (e.g., to 10% of the U.S. electricity market and beyond), will require further R&D.

DOE will collaborate with the interagency as well as industrial and international partners to explore technology options and policy needs to ensure resilient, sustainable, and economically viable supplies of fusion fuel isotopes, including from domestic sources, by the middle-to-late 2030s to support potential fusion deployment scale-up.

Example of a Commercialization Risk Starting to Be Addressed (Regulatory)

Nonproliferation Framework

Fusion plants are expected to pose a lower nuclear-proliferation risk than nuclear fission reactors. Fusion plants do not use any special nuclear material[7] used in nuclear weapons. However, D-T fusion plants and the high-energy neutrons they produce will have the potential to breed plutonium from natural uranium. In addition, D-T fusion plants will include significant inventories of tritium and lithium-6, which are used in advanced nuclear weapons. Pursuit of inertial confinement approaches to fusion energy introduces a risk of transferring specialized advanced knowledge and related simulation capabilities that could be used for nuclear-weapons development programs.

These potential proliferation risks of fusion may also impact public acceptance of fusion, which will be key for enabling the eventual broad deployment of fusion energy when it is available.[8] The DOE and NNSA will support the path toward a "right-sized" nonproliferation approach in collaboration with the U.S. fusion industry and other stakeholders through the following actions:

- **Building a community of interest through sponsored workshops and engagement with industry stakeholders, national laboratories, academia, non-governmental organizations, interagency colleagues including the Nuclear Regulatory Commission, international partners, and others as appropriate.**
- **Identifying and addressing research needs to support the establishment of an effective fusion-nonproliferation framework, including in the areas of proliferation pathway analysis; fuel-isotope management and monitoring; nexus of nonproliferation, safety regulation, social license, and equity; and inertial confinement fusion.**
- **Leveraging existing frameworks, policies, and agreements, where appropriate, such as export-control regimes, the Treaty on the Non-Proliferation of Nuclear Weapons, and the Convention on the Physical Protection of Nuclear Material.**
- **Applying DOE and NNSA technical knowledge, and that of our national laboratories and academic partners, to support all the above.**

Examples of Commercialization Risks Starting to Be Addressed

Equity, Community Perception, and Workforce

Fusion has a unique opportunity to engage the public and communities starting at the R&D stage to ensure equity throughout RDD&D; facilitate a social license for fusion energy; address public concerns and ensure dialogue; and build an inclusive, diverse workforce to deliver on the promise of fusion energy. Consent-based siting and co-design of projects can help drive economic growth and opportunities, as well as the equitable distribution of benefits and burdens, especially in communities that have borne the brunt of the energy system historically and those who are being left behind by the clean-energy transition.

For example, awardees in the Milestone Program will build meaningful relationships with their communities and invest in the education and training of an inclusive, diverse fusion workforce. By facilitating transparency, community input, social buy-in, and accountability, such engagements can substantially reduce or eliminate stalls or slowdowns, litigation, and other risks associated with future demonstration and deployment activities. Further, by including communities in the decision-making process around fusion energy throughout the RDD&D path, DOE can ensure that the benefits of fusion are realized in a way that is equitable, sustainable, and respectful of community needs and priorities.

There is a need for expanded and broader fusion workforce-development programs, expanding beyond fundamental and applied science to engineering and manufacturing disciplines, as well as expanding beyond training future researchers to a broader workforce encompassing all the specialized technical and non-technical skills needed to support a vibrant commercial fusion industry. These programs must center inclusivity and ensure accessibility for diverse communities, especially historically under-represented groups in science, technology, engineering, and math (STEM) fields. DOE will partner with and share best practices across FCT programs and agencies.

Example of a Commercialization Risk Starting to Be Addressed (Environmental and Safety)

Waste Management

Due to the generation of high-energy neutrons inherent to fusion reactions, especially for D-T fusion systems and to a lesser extent for other fusion fuel cycles, fusion will produce activated and tritiated waste. Fortunately, these wastes are not anticipated to require long-term geological storage. Nevertheless, R&D is needed to minimize waste and to develop cost-effective waste-separation, recycling, and disposal pathways.

In addition, it is critical that fusion plants are planned with decommissioning strategies in mind. DOE has learned from decades of legacy waste-cleanup experience the value of early planning for waste management. The Office of Environmental Management (through its Savannah River National Laboratory) has initiated a collaboration with the Office of Science and other FCT program stakeholders to conduct workshops to initiate the process of identifying and preparing pathways for effective fusion waste management.

These workshops will include laboratory experts, industry partners, academia, regulators, and public stakeholders. By collaborating early, EM expertise will guide an R&D plan that defines waste-management pathways in support of commercialization and a social license for fusion energy.

STRATEGY PILLAR 3:
Building and Leveraging External Partnerships

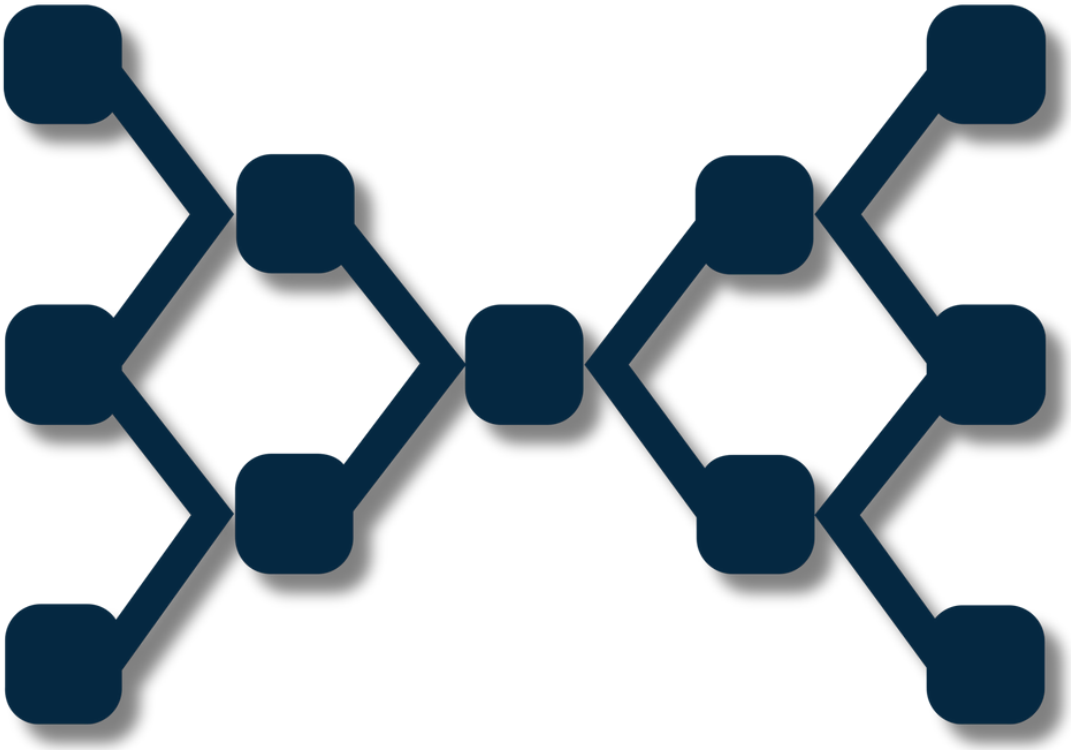
Advancing the science of fusion energy has long benefitted from external partnerships, especially international collaborations, since the 1960s. The Bold Decadal Vision's ambition to achieve timely demonstration and commercial deployment will require expanding the scope of our existing partnerships as well as cultivating entirely new ones. Starting from our objective today of accelerated R&D all the way to scale-up of commercial fusion deployment in the future, the DOE aims to build and leverage external partnerships including interagency, international, private sector, academia, non-governmental organizations (NGOs) and non-profits, philanthropy, communities, and state/local governments.

The newly established ESP division in SC FES will help implement many of these partnerships, especially strategic international partnerships, that bridge all three pillars. DOE and SC FES will leverage these partnerships to bridge foundational, enabling, and translational research; enable a holistic RDD&D approach that will help the private sector successfully demonstrate and deploy fusion plants with enhanced and innovative supply chains; improve connections between the broader plasma-science-and-technology and fusion-energy ecosystems; and build connections with local/state governments and communities through the proposed PPCF and regional hubs. These objectives will also help ensure stronger ties between academia and the private sector, ensuring innovation in the DOE and SC FES mission to support the development of a competitive U.S. fusion industry.

Interagency Cooperation

Following the announcement of the Bold Decadal Vision, the White House established a platform for interagency discussions and engagement to focus on identifying policy, legislative, and other needs to support timely fusion commercialization, in parallel with efforts to resolve the S&T gaps to a fusion pilot plant.

In addition to the commercialization topics discussed earlier under pillar 2, interagency discussions have also touched on developing resilient supply chains, exploring the adequacy of export-control frameworks around future global fusion deployment, protecting the intellectual property of the U.S. fusion industry, and developing an updated strategy for international partnerships. These and other topics will continue to be addressed through interagency engagements and collaborations.



International Partnerships

DOE will expand existing international partnerships and cultivate new ones, in support of the U.S. strategy for International Partnerships in a New Era of Fusion Energy Development, which was announced at the United Nations Conference of the Parties (COP28) in Dubai on December 5, 2023. The U.S. fusion international strategy has the five following overarching goals:

1. **Cooperation on fusion R&D including access to or shared development of test facilities.**

2. **Growing the future global fusion marketplace including supply chains.**

3. **Harmonization of regulatory frameworks to support safe and secure fusion deployment.**

4. **Foster and strengthen a global workforce pipeline.**

5. **Improving public engagement and education on fusion energy.**

In November 2023, the DOE and the U.K. Department of Net Zero and Energy Security issued a joint statement on a strategic partnership to accelerate the demonstration and commercialization of fusion energy, in support of both the Bold Decadal Vision and the UK's fusion strategy. In April 2024, the DOE issued a joint statement on a fusion strategic partnership with the Japan Ministry of Education, Culture, Sports, Science and Technology (MEXT), in support of the Bold Decadal Vision and the Japan Fusion Energy Innovation Strategy.

The work of these and other new international partnerships in the future will be driven by joint coordination committees with representation from national laboratories, academia, and private industry of each country. In addition, DOE will continue to participate in multi-lateral fusion collaborations such as ITER, and coordinate with the interagency in multi-lateral fusion discussions and activities, e.g., under the International Atomic Energy Agency (IAEA), International Energy Agency (IEA), and Group of Seven (G7).

Private Sector

The DOE will continue to build and improve its partnerships with the private sector. The fusion private sector and PPPs are critical enabling elements of the Bold Decadal Vision, which aims to leverage the approximately $6 billion of cumulative equity investments into predominantly U.S.-based fusion companies. This investment is a symbol of the market interest in an energy technology with the potential attributes of fusion energy.

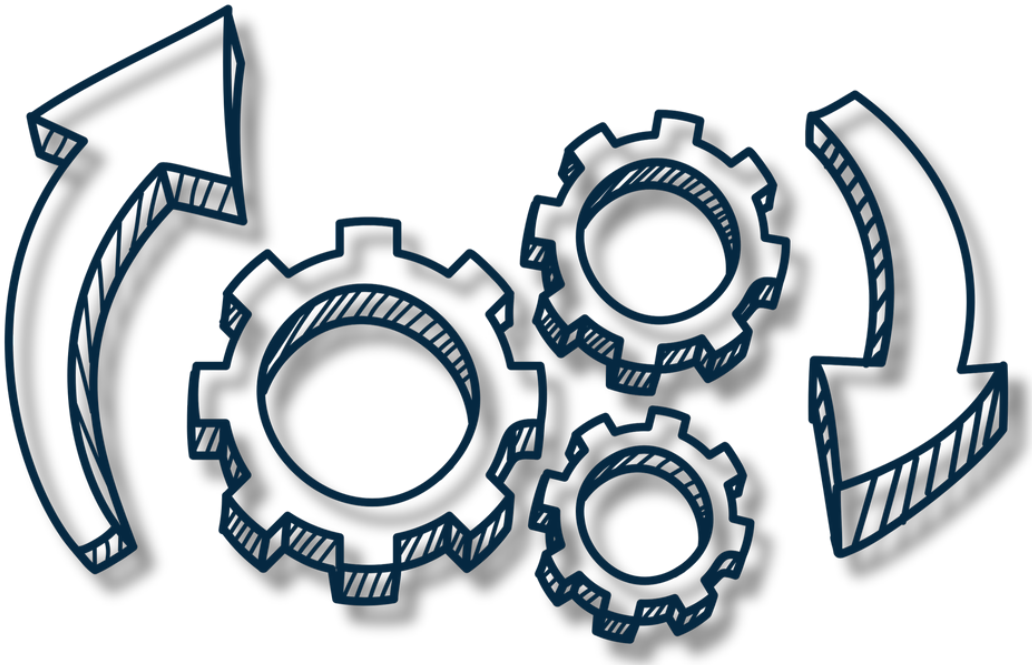
The role and makeup of the fusion private sector and the nature of PPPs will necessarily evolve as fusion progresses up the RDD&D spectrum. At the present R&D stage, activity in the private sector is dominated by investor-funded fusion developers (e.g., awardees of the Milestone Program), but there is also a growing network of supply-chain and service providers, investors, NGOs, and even future energy offtakers.[9]

As fusion development progresses into demonstration and deployment, overall spending and the range and number of private-sector participants, including engineering, procurement, and construction (EPC) firms, will increase. PPP programs to support the different stages of fusion RDD&D will be carefully designed to maximize their effectiveness and impact for achieving the needed goals and stimulating greater participation at each stage.

Equally important, any use of Other Transactions (OT) agreements for federal funding should aim to maximize the impact and effectiveness of PPPs by using the flexibilities provided by the DOE's OT authorities and ensuring the alignment of expectations early in the process to increase the speed of executing the agreements.

The degree to which flexibilities provided by the DOE's OT statutory authorities are employed should be determined by appropriately balancing federal and non-federal contributions and risks. Broader government requirements that attach to federal funding, e.g., on research security and U.S. manufacturing, should be implemented in a manner that appropriately balances the key needs of the government and the awardee.

The fusion strategy will benefit from applying lessons-learned from standing up the Milestone Program and other PPP programs to ongoing and future PPPs in support of the Bold Decadal Vision.



Academia

Universities and other educational institutions have been and will remain a critical partner on the fusion RDD&D pathway. Their traditional contributions on fundamental and applied R&D and in educational training must be nurtured and expanded from their historical emphasis on plasma science to include fusion materials and technology disciplines as well as the technical R&D areas to support pillar 2 of the strategy. In addition, the academic sector is needed to contribute to the growing non-technical needs of pillar 2, especially in the social sciences to inform broad public discourse on facilitating a social license for fusion energy (see footnote 8).

The latter is a complex topic touching on energy, environment and sustainability, waste management, nonproliferation, equity, and more. The DOE fusion strategy will look to broader engagements with academia consistent with inclusive workforce development (going beyond training future fusion researchers), including engaging with minority-serving institutions (MSIs), community colleges, vocational schools, industries with displaced workers, as well as leveraging external partnerships to increase awareness of fusion energy in K–12 educational curricula.

NGOs, Non-profits, Philanthropy

Widespread adoption of fusion energy hinges on public engagement and trust. NGOs and non-profits that have advocated for public interests, such as health and environmental sustainability, have earned public trust. Partnerships with such NGOs and non-profits will be essential to support proactive, trusted, and transparent engagements with the public that address fusion energy's benefits, costs, risks, and integration with future energy systems, while respecting the histories and needs of communities.

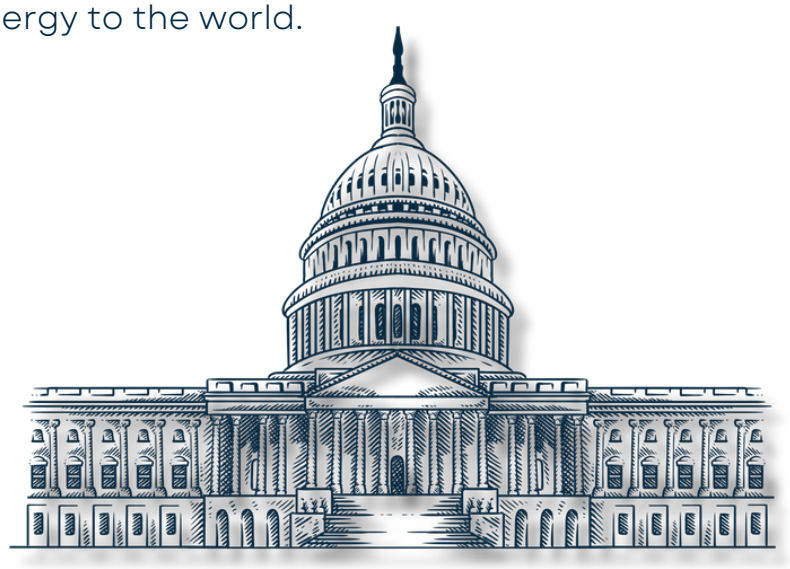
Philanthropy and government partnerships are crucial to support the work of these NGOs and non-profits. These activities and partnerships in the fusion space are very nascent today and will need to grow if fusion energy is ultimately to be welcomed into communities and widely adopted. The DOE fusion strategy will explore ways to build and bolster these partnerships.

State/Local Governments and Communities

Eventual commercial fusion deployment will ultimately require the support and buy-in of state/local governments and communities, including consent-based siting. Their decisions will be closely tied to their energy needs and policies, as well as to the economic opportunities that fusion deployment will create in communities.

In the nearer-term, the DOE's fusion strategy aims to stimulate regional and community interest and funding through its PPPs in different ways, including the Milestone Program (through supporting fusion companies and thus indirectly the local regions where they are located), the FIRE Collaboratives (through supporting the R&D ecosystems that will surround each Collaborative), and the proposed PPCF that is envisioned to be anchored by regional hubs with direct state/local government partnerships.

Regional and local engagement early in the RDD&D process is important not only to amplify federal funding to accelerate the timeline, but also to build knowledge, experience, and trust in fusion energy by local communities, which will facilitate a social license for fusion energy such that it can fulfill its promise to bring safe, clean, abundant energy to the world.



Notations

Footnote 1, located on document pg 1: DOE defines a fusion pilot plant as producing greater than 50 MW of net electricity for at least 3 continuous hours with a timely path to 1 full-power year, at a capital cost that will attract private investors and commercialization partners (adapted from the National Academies report Bringing Fusion to the U.S. Grid at: https://nap.nationalacademies.org/catalog/25991/bringing-fusion-to-the-us-grid)

Footnote 2, located on document pg 3: 42 USCS § 18645.

Footnote 3, located on document pg 7: Funding opportunity announcement (FOA): https://science.osti.gov/grants/FOAs/FOAs/2022/DE-FOA-0002809

Footnote 4, located on document pg 7: The Milestone Program's use of "Other Transactions" authority and fixed payments upon milestone completion is inspired by the NASA Commercial Orbital Transportation Services (COTS) Program that helped spawn the commercial space industry including SpaceX. The Milestone Program supports a variety of fusion approaches at different technological readiness levels, which is a feature adopted from the DOE Nuclear Energy Advanced Reactor Demonstration Program.

Footnote 5, located on document pg 8: For example, the consortium PPP between the Department of Defense and Sematech: https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Science_and_Technology/10-F-0709_A_Final_Report_to_the_Department_of_Defense_February_21_1987.pdf.

Footnote 6, located on document pg 11: Summarized on pp. 5-6 of the DOE Lead Fusion Coordinator's June 2023 written testimony to the Energy Subcommittee of the U.S. House Committee on Science, Space, and Technology: https://science.house.gov/2023/6/energy-subcommittee-hearing.

Footnote 7, located on document pg 14: Special nuclear material is defined by the U.S. Nuclear Regulatory Commission as plutonium-239, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235, and does not include source material; https://www.nrc.gov/materials/types/sp-nucmaterials.html.

Footnote 8, located on document pg 14: S. Hoedl, Journal of Fusion Energy 42, 22 (2023); https://doi.org/10.1007/s10894-023-00355-x.

Footnote 9, located on document pg 20: For example, see the membership list of the Fusion Industry Association (FIA) for the former, and the affiliate membership list of the FIA for the latter; https://www.fusionindustryassociation.org.

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