Fusion Energy Sciences

Overview

The Fusion Energy Sciences (FES) program's mission is to drive the scientific and technological foundation for a fusion energy source and support the development of a competitive U.S. fusion energy industry. The FES strategy is founded on advancing the basic research needed to solve foundational science and technology (S&T) gaps towards the development of fusion power as an affordable and reliable energy source in the U.S. using multiple tools and strategic approaches. Core capabilities in foundational S&T areas are complemented by alignment with the 2020 Fusion Energy Sciences Advisory Committee (FESAC) Long-Range Plan (LRP) Fusion Materials and Technology (FM&T) gaps, which connects the three science drivers: Sustain a Burning Plasma, Engineer for Extreme Conditions, and Harness Fusion Power.

FES supports exploitation of frontier fusion facilities in the U.S. and abroad in both public and private sectors. The Sustain a Burning Plasma program element includes R&D on domestic short-pulse toroidal facilities (e.g., DIII-D and National Spherical Torus Experiment-Upgrade (NSTX-U)) that enable international collaborations on long pulse tokamaks and stellarators abroad. U.S. world-leading Office of Science (SC) fusion toroidal platforms support artificial intelligence-fusion convergence, optimize magnetic confinement regimes and test prototype fusion technology. Inertial Fusion Energy (IFE) hubs support rapid growth of inertial confinement approaches in an expanded IFE program. FES supports U.S. participation in ITER to provide U.S. scientists access to an industrial scale burning plasma experimental facility and to help build the American fusion energy supply chain. Access to domestic private fusion facilities is also provided under a new Private Facility Research (PFR) program to both address S&T gaps and support the emerging private sector. Studies of future large-scale facilities that best serve the mission of FES and are aligned with the FESAC LRP goals of FM&T gap closure are evaluated.

Complementing facility programs is a suite of nationally coordinated public-private partnership (PPP) programs to support a growing fusion power industry. The Milestone-Based Fusion Energy Development Program supports fusion developer startup companies establish viable fusion pilot plant (FPP) designs. Fusion Innovation Research Engine (FIRE) Collaboratives address critical S&T gaps informed by the private sector. The Innovation Network for Fusion Energy (INFUSE) program provides vouchers to fusion startups to access public fusion infrastructure at national labs and universities. Fusion BRIDGE, a public-private consortium for fusion energy, accelerates cost-sharing of small and medium-scale test stands to de-risk most common and critical FM&T gaps in a network of economic regional hubs aligning advanced manufacturing, digital engineering, and infrastructure to support a U.S.-based fusion innovation supply chain. The U.S. continues to develop the overall fusion strategy and is determining how to partner with allies and industry to prioritize investments that accomplish the best and quickest outcomes to advance fusion energy.

FES supports fusion theory and simulation to enable prediction and interpretation of complex, self-organized plasma phenomena and fusion technology, and to provide validate high-fidelity physical models for plant design. To steward advanced computation for fusion energy, FES supports Scientific Discovery through Advanced Computing (SciDAC) portfolio, in partnership with the Advanced Scientific Computing Research (ASCR) program, to integrate simulation capabilities across a broad range of technical areas. The Fusion Materials and Internal Components areas address the development of novel materials and technologies that can withstand enormous heat and neutron exposure. The Material Plasma Exposure eXperiment (MPEX) facility is being constructed with the aim of addressing knowledge gaps in plasma-material interactions. The Closing the Fusion Cycle areas aim to develop the breeding and processing technology for fusion fuels that ensure fusion is a self-sustaining energy source which is important for the design basis of an FPP.

In plasma science and technology, FES supports research areas such as plasma astrophysics, space plasmas, plasma propulsion, high-energy-density plasmas (HEDP), and low-temperature plasmas. Practical societal applications of plasmas are found in plasma processing of advanced materials, plasma-enabled chemical processing, and plasma medicine. Some of this research is conducted through partnerships and/or coordination with the National Science Foundation (NSF) and the National Nuclear Security Administration (NNSA).

Within the Office of Science, FES invests in several cross-cutting initiatives such as artificial intelligence and machine learning (AI/ML), quantum information science (QIS), and microelectronics. In addition, with continued funding for the Established Program to Stimulate Competitive Research (EPSCoR), FES will build strategic programs to enhance SC-sponsored fusion-relevant research in key states and territories.

Highlights of the FY 2026 Request

The FES FY 2026 Request of $744.8 million is a decrease on net of $45.220 million below FY 2025 Enacted, primarily due to reduced funding for ITER more than offsetting increases for high priority research activities. The Request is aligned with a reassessment of how ITER fits in the overall U.S. fusion strategy, including reviewing partnerships and investment approaches to quickly advance fusion energy. The Request is aligned with recommendations in the FESAC LRP. The FY 2026 Request includes:

Research

- DIII-D research: Characterize and exploit innovative heating and current drive sources relevant for power plants including development of high-confinement, steady-state operating scenarios.
- NSTX-U research: Support collaborative research related to the optimization of tokamak aspect ratio and high field conventional tokamak studies in support of FPP development. Engage in high priority strategic FM&T initiatives.
- Partnerships with the private sector: For the Milestone-Based Fusion Development Program, support subsequent phases of research and commercialization activities of the teams that successfully met their initial milestones; continue to support the Innovation Network for Fusion Energy (INFUSE) program and the Private Facility Research (PFR) program, which started as a pilot program in FY 2025, to perform open research on private fusion and plasma S&T facilities. In addition, a new element, Fusion BRIDGE, is added to explore modalities that support PPPs aimed at developing and building small, medium, and large-scale capabilities, including test stands. These efforts are targeted toward closing critical FM&T gaps defined by both the public and private sectors.
- IFE: Enhance research activities including the IFE-STAR hubs and implement the priority research opportunities that came out of the 2022 IFE Basic Research Needs (BRN) Workshop including de-risk S&T capabilities.
- FIRE Collaboratives: Strengthen support for the multi-institutional, multi-disciplinary research and development centers to address critical S&T gaps outlined in the LRP and support public & private FPP efforts. The Request supports multiple collaboratives in four technical areas: advanced simulation, materials, blanket/fuel cycle, and enabling technologies.
- International Collaborations: Continue to exploit international, long-pulse facilities by multi-institutional teams, and complete fabrication and installation of advanced diagnostic systems on new world-leading facilities. Expand strategic international partnerships on FM&T facilities and partner to build new large-scale facilities and test stands with Fusion BRIDGE in the U.S. fusion ecosystem.
- Discovery Plasma Science and Technology: Continue support for basic plasma research and collaborative research facilities, HEDLP research and facilities, microelectronics, and plasma-based technology research, and expand QIS.
- AI/ML: Increase support for multi-disciplinary teams applying AI/ML for science discovery, data analysis, model extraction, plasma control, analysis of extreme-scale simulations, and data-enhanced prediction and control.
- EPSCoR: Strengthen fusion-relevant research capacity and capabilities in key states and territories.

Facility Operations

- DIII-D operations: Support 16 weeks of facility operations, with a new divertor allowing higher plasma performance, and complete ongoing infrastructure improvements.
- NSTX-U recovery and operations: Continue the recovery and repair activities including machine assembly and continue to support commissioning in preparation for plasma operations.

Projects

- U.S. hardware development and delivery to ITER: Support the testing and final delivery of all Central Solenoid magnet modules. Evaluate and assess the continued design, fabrication, and delivery of U.S. in-kind hardware systems, including tokamak cooling water, tokamak exhaust processing, electron and ion heating transmission lines, diagnostics, tokamak fueling, disruption mitigation, vacuum auxiliary, and roughing pumps.

- Major Item of Equipment (MIE) project for plasma-material interaction research: Continue to support the Material Plasma Exposure eXperiment (MPEX) MIE project, which includes the design, fabrication, installation, and commissioning of the MPEX linear plasma device, and associated facility modification and reconfiguration.
- SLAC National Accelerator Laboratory (SLAC) Matter in Extreme Conditions-Upgrade (MEC-U) project: Activities for the MEC-U project are on hold. There is no request for funding in FY 2026.

Other

- General Plant Projects/General Purpose Equipment (GPP/GPE): Support infrastructure improvements and repairs at the Princeton Plasma Physics Laboratory (PPPL) and other DOE laboratories.

Fusion Energy Sciences
Funding

	(dollars in thousands)			
	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
Fusion Energy Sciences				
Advanced Tokamak	139,600	–	–	–
Spherical Tokamak	98,100	–	–	–
Theory & Simulation	42,300	–	–	–
Public-Private Partnerships (old)	45,000	–	–	–
Artificial Intelligence and Machine Learning	11,000	–	–	–
Inertial Fusion Energy (IFE) (old)	15,000	–	–	–
Total, Burning Plasma Science: Foundations	**351,000**	**–**	**–**	**–**
Long Pulse: Tokamak (old)	13,000	–	–	–
Long Pulse: Stellarators	7,500	–	–	–
Materials & Fusion Nuclear Science	95,000	–	–	–
Future Facilities Studies (old)	2,000	–	–	–
Total, Burning Plasma Science: Long Pulse	**117,500**	**–**	**–**	**–**
Plasma Science and Technology (old)	33,000	–	–	–
Measurement Innovation (old)	3,000	–	–	–
Quantum Information Science (QIS) (old)	10,000	–	–	–
Advanced Microelectronics (old)	13,000	–	–	–
Other FES Research	2,500	–	–	–
Reaching a New Energy Sciences Workforce	6,000	–	–	–
FES-Funding for Accelerated, Inclusive Research (FAIR)	2,000	–	–	–
FES-Established Program to Stimulate Competitive Research (EPSCoR)	2,000	–	–	–
Total, Discovery Plasma Science	**71,500**	**–**	**–**	**–**
Theory and Simulation	–	64,000	74,600	+10,600
Fusion Materials and Internal Components	–	85,000	85,473	+473
Sustain a Burning Plasma	–	123,000	132,900	+9,900
Closing the Fusion Cycle	–	69,000	78,100	+9,100
Discovery Plasma Science and Technology	–	48,000	58,000	+10,000
Public-Private Partnerships	–	71,200	130,000	+58,800
Fusion Workforce Pathways (Parent)	–	2,000	2,000	–
FES Other Research	–	3,890	3,687	-203

	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
	(dollars in thousands)			
Total, Fusion and Plasma Research	**–**	**466,090**	**564,760**	**+98,670**
DIII-D Operations	–	71,600	57,668	-13,932
National Spherical Torus Experiment-Upgrade (NSTX-U) Operations	–	52,310	44,852	-7,458
Total, Fusion Facility Operations	**–**	**123,910**	**102,520**	**-21,390**
Subtotal, Fusion Energy Sciences	**540,000**	**590,000**	**667,280**	**+77,280**
Construction				
20-SC-61 Matter in Extreme Conditions (MEC) Petawatt Upgrade, SLAC	10,000	–	–	–
14-SC-60 U.S. Contributions to ITER	240,000	200,000	77,500	-122,500
Subtotal, Construction	**250,000**	**200,000**	**77,500**	**-122,500**
Total, Fusion Energy Sciences	**790,000**	**790,000**	**744,780**	**-45,220**

SBIR/STTR funding:
- FY 2024 Enacted: SBIR $11,805,000 and STTR $1,660,000
- FY 2025 Enacted: SBIR $14,156,000 and STTR $1,991,000
- FY 2026 Request: SBIR $17,219,000 and STTR $2,421,000

Fusion Energy Sciences
Explanation of Major Changes

	(dollars in thousands) FY 2026 Request vs FY 2025 Enacted
Fusion and Plasma Research	+$98,670
Funding for DIII-D research will continue to focus efforts on developing the scientific foundation and operating scenarios for a burning plasma. Funding for NSTX-U Research will maintain collaborative research at other facilities and establish new strategic FM&T initiatives. Both domestic assets provide a platform for convergence of AI and fusion energy development. The Request enhances support for the Fusion Development Milestone Program, continues support for Materials and increases support for Fusion Nuclear Science consistent with the FESAC LRP goals. In addition, the Request continues the FIRE Collaboratives on Structural/Plasma Facing Materials, Blanket/Fuel Cycle, Enabling Technologies, and Advanced Simulation for Design and Optimization to address the FESAC LRP gaps. The Request increases support for IFE S&T in IFE-Science and Technology Accelerated Research (STAR) hubs, maintains support for Measurement Innovation, and increases support for AI/ML research in areas such as control theory, materials design, and disruption mitigation research. The Request continues support for high-priority international collaboration activities and establish new ones, for both tokamaks and stellarators that support burning plasma studies for U.S. scientists. The Request supports continuation of the MPEX MIE project. The Request also supports Future Facilities Studies program focusing on new strategic experimental facilities addressing S&T gaps identified in the FESAC LRP. For General Plasma Science and Technology, the Request emphasizes user research on collaborative research facilities at universities and national laboratories including the Facility for Laboratory Reconnection Experiments (FLARE) at PPPL and work in emerging plasma technology topics. For HEDLP, the Request continues MEC instrument support and research on the ten LaserNetUS networked facilities. Support for SC-wide Microelectronics Science Research Centers will emphasize convergence of plasma technology and advanced microelectronic materials. The Request enhances support for QIS, which supports the core research portfolio stewarded by FES and the National QIS Research Centers. Support continues for EPSCoR. The Request continues the Private Facility Research program, which started as a pilot program in FY 2025, for fusion community to perform research on private fusion and plasma science facilities. It also adds a new element, Fusion BRIDGE, to explore models that support PPPs towards developing and building small-to-midscale test stands targeted toward closing key FM&T gaps.	
Fusion Facility Operations	-$21,390
The Request continues to support the recovery activities for the NSTX-U program, including the installation of remaining diagnostics and commissioning in preparation for plasma operations. Funding for DIII-D operations will support 16 weeks of facility operations, operate with a new divertor allowing higher plasma performance, and complete ongoing machine and infrastructure improvements.	

	(dollars in thousands)
	FY 2026 Request vs FY 2025 Enacted
Construction FES will place activities for the MEC-U project on hold as it assesses potential equipment upgrades. The U.S. Contributions to ITER project will continue design, fabrication, and delivery of the highest priority hardware contributions while a reassessment of the project in the U.S. fusion strategy is underway.	-$122,500
Total, Fusion Energy Sciences	-$45,220

Basic and Applied R&D Coordination

FES participates in coordinated intra- and inter-agency initiatives within DOE and with other federal agencies on science and technology issues related to fusion and plasma science. Within SC, FES operates the MEC instrument at the SLAC Linac Coherent Light Source (LCLS) user facility operated by the Basic Energy Sciences (BES) program, supports high-performance computing research with ASCR, uses the BES-supported High Flux Isotope Reactor (HFIR) facility at Oak Ridge National Laboratory (ORNL) for fusion materials irradiation research, and supports the construction of a high field magnet vertical test facility at the Fermi National Accelerator Laboratory with the High Energy Physics (HEP) program. Within DOE, FES manages a joint program with NNSA in HEDP science and continues to coordinate research activities with the Advanced Research Projects Agency-Energy (ARPA-E).

Program Accomplishments

Innovative Plasma Shaping Method Improves Heat Management and Mitigates Material Erosion for Fusion Power Plants

An international team of researchers at the DIII-D National Fusion Facility developed an innovative tokamak operation method by inverting the plasma boundary shape. This approach entirely avoids harmful heat exhaust spikes that enhance material erosion, while also distributing the steady-state exhaust over a larger area of the tokamak first wall, potentially extending the lifespan of critical internal components such as the tokamak divertor. By addressing the challenge of plasma-material interactions—a key element of the FESAC LRP—this innovation has significant implications for fusion power plant design and may become a preferred strategy for managing the extreme heat and particle exhaust from tokamaks, which can reach levels approximately 10,000 times higher than sunlight on Earth.

Milestone Program: Public-private partnerships to advance fusion energy

The Milestone-Based Fusion Development Program aims to accelerate progress toward commercial fusion energy. Eight teams were selected for award negotiations in this program. After extensive discussions, agreements were signed with all eight teams. The award mechanism for this first-of-a-kind Milestone program is Technology Investment Agreements, which offer flexible, tailorable, intellectual property and other terms that are more amenable to private industry participation. The eight teams selected include tokamaks, stellarators, inertial fusion energy, and alternate approaches. The Milestone program is consistent with an Overarching Recommendation from the LRP, to "Expand existing and establish new public–private partnership programs to leverage capabilities, reduce cost, and accelerate the commercialization of fusion power and plasma technologies."

Scientists Develop New 'Spark Plug' for Laser Fusion

Scientists at the University of Rochester's Laboratory for Laser Energetics (LLE) and their collaborators have developed a promising "spark plug" for direct-drive inertial confinement fusion using the OMEGA laser system. Their research demonstrates that firing 28 kilojoules of laser energy at deuterium-tritium fuel capsules successfully produces fusion reactions with an energy output exceeding that of the plasma's internal energy. These results indicate that scaling direct-drive methods to larger lasers could potentially lead to self-sustaining fusion reactions. Advances in predictive modeling and machine learning have played a significant role in these experiments.

Dynamics of nanodiamonds created by laser-driven shock-compression

Advances in laser-driven dynamic compression and bright X-ray sources have enhanced our understanding of materials under extreme conditions. Recent experiments with plastics reveal rapid nanodiamond (ND) formation within sub-nanoseconds. Simulations show that NDs disintegrate during shock release, with higher temperatures accelerating this process. Recrystallization depends on cooling rates. Laser compression of polyethylene terephthalate with X-ray probing indicates stable ND release and pressure dissipation, offering insights for efficient ND synthesis and planetary models.

Programmable quantum emitter formation in silicon

Silicon-based quantum emitters are promising for quantum technologies due to their bright telecom-band photon emission, scalability, and compatibility with existing technologies. Recent research led by Lawrence Berkeley National Laboratory has demonstrated the precise writing and erasing of light-emitting defects using femtosecond laser pulses combined with hydrogen-based activation and passivation. By selecting forming gases during the thermal annealing of carbon-implanted silicon, researchers can control the formation of various quantum emitters. This technique enables the programmable formation of specific quantum emitters.

Description

This subprogram advances our scientific understanding of how to control and sustain a burning plasma utilizing both simulation and experimental results from domestic and international devices. The subprogram supports the development of the required materials, breeding blanket and fusion fuel-cycle technology that can withstand the harsh fusion environment and harness this power to make fusion a future energy source. Innovation in this subprogram establishes the foundation of a competitive fusion power industry in the U.S. through partnerships with the private sector and allied nations on fusion technology development projects. In addition, it supports research that explores the fundamental properties and complex behavior of matter in the plasma state, making plasma science and technology fully available to support the U.S. economic growth and safeguard national security. The Fusion Innovation Research Engine (FIRE) Collaboratives provide coordination among program elements to address critical scientific and technology gaps in fusion energy. Fusion BRIDGE supports the small-to-medium test stands to, in part, help support R&D in FIRE Collaboratives.

Theory and Simulation

The Theory and Simulation activity supports research on foundational theory to advance the scientific understanding of the behavior of fusion plasmas, and multi-institutional interdisciplinary efforts under the Scientific Discovery through Advanced Computing (SciDAC) program, in partnership with the Advanced Scientific Computing Research (ASCR) program, to accelerate scientific discovery in fusion plasma science and technology. This activity also includes the FIRE Collaboratives for advanced simulations for design and optimization, which addresses critical scientific gaps for Fusion Pilot Plant (FPP) concepts in coordination with the other FIRE Collaboratives. This program supports the application of Artificial Intelligence/Machine Learning (AI/ML) techniques encompassing multiple Fusion Energy Sciences (FES) areas including digital engineering in partnership with data and computational scientists through collaborations.

Fusion Materials and Internal Components

Developing materials that can meet the needs of a fusion power plant is a grand challenge in the field of Materials Science and Engineering. Every component, from the innermost chamber walls to the outer power-plant structure, requires materials that can withstand a broad range of conditions, including extremes of heat and particle exposure, especially high energy neutron fluxes. This program aims to advance the understanding of material properties to support predictions of evolving material properties in prototypic fusion power plant environments with the aim to maximize material lifetime and performance. This activity includes FIRE Collaboratives and research capabilities to address many of the difficult and unique fusion materials challenges. The Material Plasma Exposure eXperiment (MPEX) Major Item of Equipment (MIE) project, which is a new U.S. materials experimental capability initiated in FY 2019, will enable researchers to find solutions for the challenges associated with plasma-facing materials, including exposing irradiated samples, and understanding materials degradation in the fusion nuclear environment.

Sustain a Burning Plasma

The Sustain a Burning Plasma (SBP) activity supports a diversity of approaches to confinement of plasmas in fusion energy systems. This element includes traditional toroidal confinement approaches such as advanced tokamaks (ATs), spherical tokamaks (STs) and stellarators. As these approaches address physics and technology gaps and outcomes are translated to development programs, novel approaches, such as linear plasma concepts (field-reverse configuration, axisymmetric mirrors, and plasma pinches), are nurtured and expanded. This element also includes innovative Inertial Fusion Energy (IFE) approaches.

The Toroidal Long Pulse (TLP) area advances steady-state fusion energy approaches by leveraging a coordinated network of tokamaks and stellarators in the U.S. and internationally. Facilities such as the DIII-D National Fusion Facility (an Office of Science user facility), JT-60SA in Japan, and Wendelstein 7-X (W7-X) in Germany support research on long-pulse plasma performance, exhaust handling, and advanced control systems. Guided by the priorities of the Fusion Energy Sciences Advisory Committee (FESAC) Long-Range Plan (LRP) and the National Fusion Science and Technology Roadmap, TLP integrates experimental research, predictive modeling, and AI-driven approaches while building a strong research community and workforce. Supported teams are organized around urgent, high priority technical scopes, making them well-positioned and available for collaboration with the growing private fusion industry. The program is evolving toward a more comprehensive and strategic organization to accelerate progress toward practical magnetic confinement fusion energy while continuing to leverage domestic capabilities. The domestic stellarator program remains focused on improving this concept through the quasi-symmetric shaping of the magnetic field.

The Compact Toroidal Concepts (CTC) area supports research necessary to develop a compact toroidal configuration. Two promising concepts addressed in CTC are the spherical tokamak (ST), such as the National Spherical Torus Experimental Upgrade (NSTX-U), and conventional aspect ratio tokamaks operated at high toroidal magnetic fields, exemplified by the SPARC tokamak. These devices offer complementary strategies for improving confinement and achieving compactness: STs leverage enhanced plasma physics properties while high-field conventional tokamaks rely on high-field magnets. Regardless of the approach, enabling technologies are essential for delivering these compact designs, including high-temperature superconducting magnets, liquid metal plasma-facing components, and non-solenoidal startup techniques that could eliminate the need for a central solenoid to drive plasma current. With several private sector stakeholders pushing the frontiers, the CTC program naturally incorporates the fusion energy industry and fosters strong connections to foundational S&T research.

The IFE area supports the scientific foundations and enabling technologies critical to advancing IFE. Priority research areas include improving target physics, reducing laser-plasma instabilities, developing scalable methods for target fabrication, and creating advanced, radiation-hardened diagnostics capable of operating at high repetition rates. These efforts are supported by the IFE Science & Technology Accelerated Research (IFE-STAR) hubs. The program also emphasizes ecosystem stewardship by fostering collaboration among national laboratories, academic institutions, and the private sector.

The Measurement Innovation area supports the development of world-leading transformative and innovative diagnostic techniques and their application to new, unexplored, or unfamiliar plasma regimes or scenarios. The Future Facilities Studies activity supports studies and research for required facilities that "best serve fusion" and are critical to the development of fusion energy and address needs of both the public and private sectors aligned with the FESAC Long Range Report in 2020 and FESAC Facility Construction Projects Report in 2024.

<u>Closing the Fusion Cycle</u>

Within a fusion energy system, subsystems sustain plasma conditions, extract energy, fuel the plasma, and manage waste. This research area aims to build the capabilities to design and mature each system while simultaneously integrating them efficiently to realize practical fusion power. This includes developing the next generation of real-time systems for plasma control, qualifying blankets that breed fusion fuel, and prototyping fuel-processing technologies that can optimize and sustain the fusion reaction. This activity supports enabling research and development (R&D), fusion nuclear science, FIRE Collaboratives, and research capabilities to advance the readiness of these critical capabilities.

<u>Discovery Plasma Science and Technology</u>

Discovery Plasma Science and Technology (DPST) research supports activities in high energy density laboratory plasmas (HEDLP), foundational plasma science research, transformational plasma science technology, innovation in advanced microelectronics, and efforts in the convergence of plasmas and quantum information science.

Research in HEDLP explores the behavior of plasmas at extreme conditions of temperature, density, and pressure. This activity also includes LaserNetUS, a geographically distributed network of ten high-intensity laser facilities that provide students and scientists with broad access to unique facilities and enabling technologies and advances the frontiers of HED and laser science research.

General Plasma Science and Technology (GPST) research in foundational plasma science and technology aims to increase our understanding of the complex behavior of the plasma state, ranging from astrophysical plasma to low-temperature plasma. GPST supports collaborative research facilities, enabling experiments in new regimes to enhance our understanding of plasma phenomena in nature and in the laboratory. Transformational plasma science technology includes frontier research in low-temperature plasmas, microelectronics, and plasma-based technologies with applications in medicine, space plasmas, plasma-enabled chemical reactions, environmental remediation, and agriculture.

The Advanced Microelectronics activity supports discovery plasma research in a multi-disciplinary, co-design framework to accelerate plasma-based microelectronics fabrication and advance the development of microelectronic technologies.

Quantum Information Science (QIS) activity supports basic research in QIS that can have a transformative impact on FES mission areas as well as research that takes advantage of unique FES-enabled capabilities to advance QIS development.

Public-Private Partnerships

Resilient Public-Private Partnerships (PPPs) will foster bridges between the public and private sectors to address foundational gaps and accelerate fusion toward commercial viability.

Within this PPP framework, the Innovation Network for Fusion Energy (INFUSE) program provides private-sector fusion companies with access to world-class expertise and capabilities at DOE's national laboratories and U.S. universities to overcome critical scientific and technological hurdles.

The Fusion Development Milestone Program aims to accelerate progress toward the development of commercial fusion energy through PPPs, with near-term goals of delivering preconceptual designs and technology roadmaps for a FPP and enabling significant performance improvements of FPP concepts. In fiscal year 2024, the Fusion Development Milestone Program established eight public-private partnerships, and multiple milestones have been met by the teams to date. The current awardees are working toward presenting pre-conceptual designs and technology roadmaps of their FPP concepts within the first 18 months of the Milestone program—roughly by late calendar year 2025. If they successfully meet these milestones, they will proceed into the next phase of the Milestone Program, where the awardees are planning to build and operate integrated experiments and/or demonstrate some of the critical underlying technologies for their FPPs. Since selection, four teams have collectively raised over $386 million of new private funding, compared to the $46 million of federal funding initially committed. Continued progress in the Milestone program is contingent on Congressional appropriations, successful negotiation of future milestones, and successful progress in the program including awardees success in securing the required non-Federal funding to complete their milestones

The Private Facilities Research (PFR) Program offers the opportunity for researchers to conduct open scientific studies on privately constructed facilities for the mutual benefit of all parties. This activity also includes support for Fusion BRIDGE, a public-private consortium model to develop small-to-midscale test stands.

Fusion Workforce Pathways

Fusion Workforce Pathways is a workforce development effort focused on preparing a skilled talent base to support the growing needs of the fusion energy sector. By fostering interactions among industry, educational institutions, and public institutions, the program aims to align training and education with emerging technical demands. It emphasizes research experience, specialized training, and career development in enabling technical areas such as fusion engineering, plasma physics, and simulation to ensure a robust and adaptable workforce for the future. It includes Established Program to Stimulate Competitive Research (EPSCoR) initiatives to provide opportunities to U.S. regions with potential to build critical expertise and capacity.

Other Research

This activity supports the Postdoctoral Research Program, FESAC, multiple fusion and plasma science outreach programs, critical general infrastructure, and environmental monitoring at the Princeton Plasma Physics Laboratory (PPPL) and other DOE laboratories, and other programmatic activities.

Fusion Energy Sciences
Fusion and Plasma Research

Activities and Explanation of Changes

(dollars in thousands)

FY 2025 Enacted		FY 2026 Request	Explanation of Changes FY 2026 Request vs FY 2025 Enacted
Fusion and Plasma Research	**$466,090**	**$564,760**	**+$98,670**
Theory and Simulation	$64,000	$74,600	+$10,600
Funding supports efforts at universities, national laboratories, and private industry focused on the fundamental theory of fusion plasmas. Funding continues to support SciDAC portfolio, FIRE Collaboratives in advanced simulation and design, and cross-cutting interdisciplinary fusion energy R&D towards FPP.		The Request will continue to support efforts focused on the fundamental theory of fusion plasmas, the fourth and final year of the SciDAC portfolio, the development of advanced simulation tools for the FIRE Collaborative and AI/ML research in cross-cutting interdisciplinary fusion energy and plasma science research.	Prioritization with theory and SciDAC will aligned this research with LRP priorities. Funding will continue to support FIRE Collaboratives. Funding for AI/ML research will increase to align with DOE priorities and FPP design efforts.
Fusion Materials and Internal Components	$85,000	$85,473	+$473
Funding supports growth in the key area of materials which is critical in developing the scientific foundation for fusion energy. Funding continues to support the FIRE Collaboratives for structural and plasma-facing materials which will focus their efforts on addressing the scientific and technical gaps identified in the FESAC LRP as well as in recent community workshops. Funding continues to support the MPEX MIE project, consistent with the approved baseline for the project.		The Request will enable growth in the key area of materials which is critical in de-risking gaps for fusion energy. The Request will continue to support the FIRE Collaboratives for structural and plasma facing materials. The Request will also continue to support the MPEX MIE project, consistent with the approved baseline for the project.	Funding will continue to support the research on structural and plasma-facing materials to address the scientific/technical gaps in these programs. Funding for the MPEX MIE project will support the project's approved cost/schedule baseline.
Sustain a Burning Plasma	$123,000	$132,900	+$9,900
Funding supports research at DIII-D to close remaining S&T gaps for sustaining a burning plasma. In addition, the DIII-D platform supports convergence of AI and fusion energy as well as training opportunities for the next generation of fusion researchers. Funding also supports compact toroid concepts including		The Request will support research efforts at DIII-D and lays the groundwork for the initiation of NSTX-U research activities. The Request supports small-scale U.S. experimental facilities to help close scientific gaps, supports research on international facilities for both tokamak and stellarator	Funding will support DIII-D and NSTX-U platforms aligned with priorities in FESAC LRP and key science drivers. IFE R&D will continue to grow to be aligned with priorities in expanded inertial fusion development.

FY 2025 Enacted	FY 2026 Request	Explanation of Changes FY 2026 Request vs FY 2025 Enacted
spherical tokamaks as an option of compact low-cost fusion power plant approaches. Funding supports an integrated tokamak program bridging short-pulse domestic platforms to international devices addressing S&T gaps in sustaining burning plasmas with advanced diagnostics and model validation. This supports a growing program in stellarators primarily funding activities on W7-X. Funding supports a growing IFE program consistent with FES priorities.	concepts, and supports the priority research opportunities identified in the IFE BRN Workshop. The development of innovative and transformative diagnostics and studies to help define requirements for future facilities are continued.	
Closing the Fusion Cycle $69,000	$78,100	+$9,100
Funding continues to grow in the key areas of fusion nuclear science and enabling R&D which are critical in developing the scientific foundation for fusion energy. Funding continues to support the FIRE Collaboratives for blanket/fuel cycle and enabling technologies which will focus their efforts on addressing the scientific and technical gaps identified in the FESAC LRP as well as in recent community workshops.	The Request will support the key areas of fusion nuclear science and enabling R&D, including the FIRE Collaboratives for blanket/fuel cycle, and enabling technologies, which are critical in developing the scientific foundation and technology development for fusion energy.	Increase will support new fusion technology capabilities necessary to close key gaps in blanket and fusion fuel cycle.
Discovery Plasma Science and Technology $48,000	$58,000	+$10,000
Funding continues to support basic and translational science, MEC and LaserNetUS operations and user support, and the SC-NNSA joint program. Funding continues support for discovery plasma science and low-temperature plasma R&D. Funding continues for QIS R&D as well as the National QIS Research Centers. In addition, support continues for advanced Microelectronics research.	The Request, in HEDLP, will continue to support basic and translational science and MEC and LaserNetUS operations. In GPST, it will continue to support basic and low temperature plasma science as well as operations of research facilities. For Advanced Microelectronics, it will continue to support the centers selected in FY 2025 and the priority research opportunities identified in the recent workshop. For QIS, it will continue to support the research awards as well as the National QIS Research Centers.	Funding will support the highest-priority activities including QIS, plasma technology, and FLARE facility.

FY 2025 Enacted		FY 2026 Request	Explanation of Changes FY 2026 Request vs FY 2025 Enacted
Public-Private Partnerships	$71,200	$130,000	+$58,800
Funding supports public-private partnerships through the Fusion Development Milestone Program and the INFUSE program, both of which connect the private sector to DOE developed capabilities at national laboratories and universities. A new Private Facility Research pilot program is initiated which offers the opportunity for publicly funded researchers to conduct open scientific studies on privately constructed facilities for the mutual benefit of all parties.		The Request will support PPPs through the Fusion Development Milestone Program, the INFUSE program, and the PFR program which started as a pilot program in FY 2025. The Request will also allocate funding to Fusion BRIDGE to support PPPs towards developing and building small-to-midscale capabilities.	Funding increase will support subsequent phases of the Fusion Development Milestone Program, the PFR program, and the new Fusion BRIDGE initiative.
Fusion Workforce Pathways	$2,000	$2,000	$ —
Funding supports EPSCoR State-National Laboratory Partnership awards and early career awards.		The Request will continue to support EPSCoR State-National Laboratory Partnership awards and early career awards.	Funding will support the highest priority activities aligned with FESAC LRP.
Other Research	$3,890	$3,687	-$203
Funding continues to support programmatic activities such as the FES Postdoctoral Research Program, the FES Fusion and Plasma Science Outreach programs, the U.S. Burning Plasma Organization, peer reviews and project activities, and FESA, along with infrastructure improvements, repair, maintenance, and environmental monitoring at PPPL and other DOE laboratories.		The Request will continue to support programmatic activities and infrastructure improvements.	Funding will support the highest priority activities aligned with FESAC LRP.

Note:

- *Funding for the subprogram above includes 3.65 percent of research and development (R&D) funding for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs, excluding facility operations.*

Description

The DIII-D National Fusion Facility and the National Spherical Torus Experiment-Upgrade (NSTX-U) facility are world-leading Office of Science (SC) user facilities for experimental research used by scientists from national laboratories, universities, and private industry research groups to optimize magnetic confinement regimes and test prototype fusion technology in an integrated environment. The operation of these facilities addresses the FESAC Long-Range Plan Fusion Science & Technology recommendation to "utilize research operations on DIII-D and NSTX-U, and collaborate with other world-leading facilities, to ensure that Fusion Pilot Plant (FPP) design gaps are addressed in a timely manner." Gaps that can be addressed by the operation of the FES user facilities include novel heating and current drive technology, low aspect ratio physics, disruption avoidance and mitigation, plasma control, core-edge integration, steady state burning plasma scenario development, and plasma facing component integration, including assessment of liquid metal approaches. These user facilities provide a valuable resource to the private fusion energy sector to resolve science and technology challenges associated with their confinement concepts. In addition, they play a key role in the convergence of AI and fusion energy and have a significant role in training the next generation of fusion scientists and permitting the U.S. research community to take full advantage of operations on international facilities.

DIII-D Operations

The DIII-D scientific user facility at General Atomics (GA) is the most adaptable and well diagnosed magnetic confinement facility in the U.S. Its extensive set of advanced diagnostic systems, evolving set of heating and current drive actuators, and multi-institutional research team make it well suited for closing science and technology gaps and building foundational understanding that enables extrapolation of results to burning plasma conditions. In FY 2024, the program continued to both operate and enhance the facility, supporting 692 onsite and remote users from 98 institutions and 16 countries. It engaged 24 faculty members and 201 students, representing one of the largest contributions to the U.S. fusion workforce. Experimental thrusts focus on exploiting new divertor configurations, assessing a wide range of first wall material options, developing new high-powered heating systems for fusion pilot plants, validating predictive models of energetic particles, and pushing the limits and physics understanding of opaque plasmas. The FY 2026 Request will support 16 weeks of operations, operation with increased heating power for plasma electrons, exploitation of the High-Field Side Lower Hybrid Current Drive system, and training opportunities for the next generation of fusion researchers. Longer-term, the facility will focus on integrated core-edge solutions for the FPP, burning plasma transport and performance optimizations, plasma stability control solutions, validation of simulation predictions, assessment of compatibility of viable FPP scenarios with relevant first wall materials, testing novel technology for plasma fueling, and evaluating the viability of negative triangularity shaped plasmas for fusion plants.

National Spherical Torus Experiment-Upgrade (NSTX-U) Operations

The NSTX-U scientific user facility at Princeton Plasma Physics Laboratory (PPPL) is used to close remaining and critical S&T gaps of the Spherical Tokamak (ST) magnetically confined plasma configuration. The ST has a toroidal magnetic field shaped like a cored apple and low values (<2) of aspect ratio, the ratio of the major to minor radius of the torus. Previous experiments and high-fidelity simulations indicate that STs may offer improved energy confinement relative to larger (>3) aspect ratio tokamaks. The NSTX-U program aims to show that the ST may enable higher fusion power density (reduced device size) and reduced recirculating power (improved economics) leading to affordable and compact fusion power plant option on a path to fusion energy commercialization. NSTX-U is the world's most powerful ST, with external heating of approximately 19 megawatts, toroidal magnetic fields as high as one Tesla, and plasma currents as high as two megaamperes. Combining an upgraded neutral beam heating system with unique ST plasma properties, NSTX-U is also an ideal test bed for studying interactions between plasma waves and fast fuel ions in ways that are relevant to burning plasma science. NSTX-U also provides a unique exhaust environment for testing emerging plasma-facing component systems. The FY 2026 Request will continue to support the machine assembly, system testing and commissioning, and preparation for plasma operations.

Fusion Energy Sciences
Fusion Facility Operations

Activities and Explanation of Changes

(dollars in thousands)

FY 2025 Enacted		FY 2026 Request	Explanation of Changes FY 2026 Request vs FY 2025 Enacted
Fusion Facility Operations	**$123,910**	**$102,520**	**-$21,390**
DIII-D Operations	$71,600	$57,668	-$13,932
Funding supports 16 weeks of operations at the DIII-D facility. Research continues to exploit innovative current drive systems to assess their potential as actuators for a fusion pilot plant and to optimize plasma performance. include increasing electron cyclotron power, completing the installation of the high-field-side lower hybrid current drive system and commencing experiments.		The Request will support 16 weeks of operations at the DIII-D facility, including exploitation of the high-field-side lower hybrid current drive system installed in FY 2025. Support will continue for enhancements to the DIII-D electron heating system, up to ten gyrotrons providing 7 MW of injected power.	Funding will support the highest priority work elements of the electron heating system with other facility enhancements deferred or paused. Facility operating time is prioritized.
National Spherical Torus Experiment-Upgrade (NSTX-U) Operations	$52,310	$44,852	-$7,458
Funding for operations supports the remaining NSTX-U Recovery fabrication and machine reassembly activities and begins supporting the commissioning of auxiliary heating systems in preparation for plasma operations.		The Request will support NSTX-U Recovery fabrication and machine reassembly activities.	Funding will support the highest priority work elements of the NSTX-U Recovery effort and preparation for operations.

Description

This subprogram supports all line-item construction projects. All Total Estimated Costs (TEC) are funded in this subprogram.

14-SC-60 U.S. Contributions to ITER

The ITER facility, currently under construction in Saint Paul-lez-Durance, France, is designed to provide fusion power output approaching reactor levels of hundreds of megawatts, sustained as a burning plasma for hundreds of seconds. ITER provides an experimental industrial-scale platform supporting the development of energy pilot plants in the private sector and enabling U.S. supply chains helping to keep the U.S. competitive internationally. Construction of ITER is governed under an international agreement (the "ITER Joint Implementing Agreement"). As a co-owner and Member of ITER, the U.S. contributes in-kind hardware components and financial contributions for the ITER Organization (IO) management and overhead (e.g., design integration, nuclear licensing, quality control, safety, overall project management, and installation and assembly of the components provided by the U.S. and other Members). The IO also employs over 30 U.S. nationals who work on site.

An independent review of Critical Decision-2 (CD-2), "Approve Performance Baseline," for the U.S. Contributions to ITER—First Plasma subproject (SP-1) was completed in November 2016 and then subsequently approved by the Project Management Executive on January 13, 2017, with a total project cost (TPC) of $2,500,000,000. Responding to Congressional direction in the FY 2021 Appropriations Act, the entire project was baselined in December 2023 and achieved CD-2/3B, which includes a rebaseline of SP-1 scope, baseline of Post-First Plasma (SP-2) scope, and financial contributions for the project to CD-4, "Approve Project Completion". U.S. Contributions to ITER will include the delivery of the completed Central Solenoid Magnet System, Steady-State Electrical Network, Disruption Mitigations System, Tritium Exhaust Processing System, Ion Cyclotron Heating and Electron Cyclotron Heating Systems, Diagnostics, and Roughing Pumps. U.S. investment in ITER has advanced the nation's industrial capabilities supporting a U.S. fusion power industry and resulted in over $1.4B awarded to American companies through 2024 in 46 states. US companies, DOE labs and U.S. universities contribute to the design, fabrication, and delivery of in-kind hardware for ITER.

The FY 2026 Request of $77,500,000 will support the continued systems design, fabrication, and delivery of in-kind hardware. The revised baseline is $6,500,000,000, which includes all U.S. in-kind hardware and financial construction contributions through the completion of the ITER project. The IO provided an updated baseline at the June 2024 ITER Council meeting. U.S. Contributions to ITER are estimated to remain within the TPC of $6,500,000,000.

The U.S. in-kind contribution represents 9.09 percent (1/11th) of the overall ITER project but will provide U.S. researchers and industry access to 100 percent of the science and engineering associated with what will be the largest magnetically confined burning plasma experiment ever created. The U.S. involvement in ITER is consistent with the recommendations of the FESAC LRP, and it was ranked as a top priority by the FESAC *Facilities Construction Projects*[a] assessment. ITER also contributes to FES PPPs through the sharing of design information as well as lessons learned in the design, fabrication, and installation of hardware to sustain ITER operating conditions. The Request is aligned with a reassessment of how ITER fits in the overall U.S. fusion strategy, including reviewing partnerships and investment approaches to quickly advance fusion energy.

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[a] https://science.osti.gov/-/media/fes/fesac/pdf/2024/FCPREPORT--final-submittedapproved0424.pdf

Activities and Explanation of Changes

(dollars in thousands)

FY 2025 Enacted		FY 2026 Request	Explanation of Major Changes FY 2026 Request vs FY 2025 Enacted
Construction	**$200,000**	**$77,500**	**-$122,500**
14-SC-60, U.S. Contributions to ITER (Historical)	$200,000	$77,500	-$122,500
Funding continues to support design and fabrication of in-kind hardware systems and requested construction financial contributions.		The Request will support continued design and fabrication of in-kind hardware systems.	Funding will support design and fabrication of the highest priority in-kind hardware contributions.

Fusion Energy Sciences
Capital Summary

	(dollars in thousands)					
	Total	Prior Years	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
Capital Operating Expenses						
Capital Equipment	N/A	N/A	40,400	46,400	49,380	+2,980
Total, Capital Operating Expenses	**N/A**	**N/A**	**40,400**	**46,400**	**49,380**	**+2,980**

Capital Equipment

	(dollars in thousands)					
	Total	Prior Years	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
Capital Equipment						
Major Items of Equipment						
Fusion and Plasma Research						
Material Plasma Exposure eXperiment (MPEX)	188,736	117,456	23,900	22,200	25,180	+2,980
Total, MIEs	N/A	N/A	23,900	22,200	25,180	+2,980
Total, Non-MIE Capital Equipment	N/A	N/A	16,500	24,200	24,200	–
Total, Capital Equipment	**N/A**	**N/A**	**40,400**	**46,400**	**49,380**	**+2,980**

Note:
- The Capital Equipment table includes MIEs with a Total Estimated Cost (TEC) > $10M.
- The total estimated cost for MPEX is $187,036,000. The actual amount obligated in FY 2024 is $22,200,000 and is not reflected in this table.

Fusion Energy Sciences
Major Items of Equipment Description(s)

<u>Burning Plasma Science: Long Pulse MIEs:</u>

Material Plasma Exposure eXperiment (MPEX)

FES is developing a first-of-a-kind, world-leading experimental capability to explore solutions to the plasma-materials interactions challenge. This device, known as MPEX, will be located at ORNL and will enable dedicated studies of reactor-relevant plasma-material interactions at a scale not previously accessible to the fusion program. The overall goal of this project is to create a new class of fusion materials science enabling the study of the combined effects of fusion-relevant heat, particle, and neutron fluxes for the first time anywhere in the world. The project received CD-2/3 "Approve Performance Baseline/Start of Construction" on August 22, 2022, with a TPC of $201,000,000. The FY 2026 Request includes $25,180,000 in TEC funding and $293,000 in Other Project Costs (OPC) funding and allows the project to execute the approved performance baseline. MPEX scope includes the design, fabrication, installation, and commissioning of the MPEX linear plasma device, as well as associated facility and infrastructure modifications and reconfiguration.

Fusion Energy Sciences
Construction Projects Summary

(dollars in thousands)

	Total	Prior Years	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
20-SC-61, Matter in Extreme Conditions (MEC) Petawatt Upgrade, SLAC						
Total Estimated Cost (TEC)	448,700	55,487	10,000	-	-	-
Other Project Cost (OPC)	12,300	6,900	-	-	-	-
Total Project Cost (TPC)	**461,000**	**62,387**	**10,000**	**-**	**-**	**-**
14-SC-60, U.S. Contributions to ITER						
Total Estimated Cost (TEC)	6,429,698	2,595,617	240,000	200,000	77,500	-122,500
Other Project Cost (OPC)	70,302	70,302	-	-	-	-
Total Project Cost (TPC)	**6,500,000**	**2,665,919**	**240,000**	**200,000**	**77,500**	**-122,500**
Total, Construction						
Total Estimated Cost (TEC)	N/A	N/A	250,000	200,000	77,500	-122,500
Other Project Cost (OPC)	N/A	N/A	-	-	-	-
Total Project Cost (TPC)	N/A	N/A	250,000	200,000	77,500	-122,500

Fusion Energy Sciences
Scientific User Facility Operations

The treatment of user facilities is distinguished between two types: TYPE A facilities that offer users resources dependent on a single, large-scale machine; TYPE B facilities that offer users a suite of resources that is not dependent on a single, large-scale machine.

(dollars in thousands)

	FY 2024 Enacted	FY 2024 Current	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
Scientific User Facilities - Type A					
DIII-D National Fusion Facility	**131,600**	**124,311**	**114,600**	**97,668**	**-16,932**
Number of Users	692	692	550	500	-50
Achieved Operating Hours	–	585	–	–	–
Planned Operating Hours	560	585	640	640	–
Unscheduled Down Time Hours	–	109	–	–	–
National Spherical Torus Experiment-Upgrade	**98,100**	**94,906**	**82,310**	**69,852**	**-12,458**
Number of Users	430	332	380	350	-30
Total, Facilities	**229,700**	**219,217**	**196,910**	**167,520**	**-29,390**
Number of Users	1,122	1,024	930	850	-80
Achieved Operating Hours	–	585	–	–	–
Planned Operating Hours	560	585	640	640	–
Unscheduled Down Time Hours	–	109	–	–	–

Notes:
- *Achieved Operating Hours and Unscheduled Downtime Hours will only be reflected in the Congressional budget cycle which provides actuals.*
- *Percent optimal operations defines what is achieved at this funding level. This includes staffing, up-to-date equipment and software, operations and maintenance, and appropriate investments to maintain world leadership.*

Fusion Energy Sciences
Scientific Employment

	FY 2024 Enacted	FY 2025 Enacted	FY 2026 Request	FY 2026 Request vs FY 2025 Enacted
Number of Permanent Ph.Ds (FTEs)	1,025	1,141	1,050	-91
Number of Postdoctoral Associates (FTEs)	127	141	120	-21
Number of Graduate Students (FTEs)	342	380	350	-30
Number of Other Scientific Employment (FTEs)	1,528	1,703	1,550	-153
Total Scientific Employment (FTEs)	**3,022**	**3,365**	**3,070**	**-295**

Note:
- *Other Scientific Employment (FTEs) includes technicians, engineers, computer professionals, and other support staff.*

14-SC-60 U.S. Contributions to ITER
Project is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

<u>Summary</u>

The FY 2026 Request for the U.S. Contributions to ITER (U.S. ITER) project is $77,500,000 of Total Estimated Cost (TEC) funding. The Total Project Cost (TPC) for the project is $6,500,000,000. In FY 2023, the entire U.S. ITER project was baselined, with a TPC of $6,500,000,000 which included all the Subproject-1 (SP-1) and Subproject-2 (SP-2) scope, as well as the total construction cash contributions to the ITER Organization (IO). The U.S. involvement in ITER is consistent with the recommendations of the FESAC LRP, and it was designated as a facility that “best serves” the FES mission by the FESAC *Facilities Construction Projects*[b] assessment. U.S. Contributions to ITER also supports a U.S. fusion supply chain that supports the growing fusion power industry. ITER also contributes to FES public-private partnerships through the sharing of design information as well as lessons learned in the design, fabrication, and installation of hardware to sustain ITER operating conditions. Sections of this Construction Project Data Sheet (CPDS) have been tailored to reflect the unique nature of the U.S. ITER project. The Request is aligned with a reassessment of how ITER fits in the overall U.S. fusion strategy, including reviewing partnerships and investment approaches to quickly advance fusion energy.

<u>Significant Changes</u>

The U.S. ITER project was initiated in FY 2006. On January 13, 2017, U.S. ITER SP-1 achieved both Critical Decision (CD)-2, “Approve Performance Baseline,” and CD-3, “Approve Start of Construction.” CD-4, “Project Completion,” for SP-1 is currently planned for December 2028.

In response to Congressional direction articulated in the Consolidated Appropriations Act 2021 to baseline the entire project, the full requirement to complete the U.S. Contributions to ITER project was baselined in December 2023. The U.S. baselined the entire U.S. Contributions to ITER project, including re-baselining SP-1 and the baselining of SP-2 as a result of the IO rebaselining for the overall project due to COVID and first-of-a-kind component delivery delays, material specification and fabrication issues as well as quality challenges. The IO submitted an updated cost and schedule to the ITER Council at the June 2024 meeting which delays machine startup. This submittal was assessed by a U.S.-led Independent Assessment (IA) team consisting of several ITER members and its conclusions presented to the ITER IO in Fall of 2024. The IA report, along with other input, is currently supporting a reassessment of ITER and how it fits the overall U.S. strategy on fusion energy.

In FY 2024, one Central Solenoid Module (CSM) was delivered, bringing the total to four of seven that make up the Central Solenoid Magnet (including one spare). Two additional CSMs are scheduled for delivery to the IO in FY 2025. The first fabrication contract was awarded for the Electron Cyclotron Heating system in FY 2025. The FY 2025 funding supports the continued systems design, fabrication, and delivery of in-kind hardware, and financial contributions for IO construction operations. The FY 2026 Request will support the continued design and fabrication of multiple in-kind hardware with no cash contribution.

[b] https://science.osti.gov/-/media/fes/fesac/pdf/2024/FCPREPORT--final-submittedapproved0424.pdf

Critical Milestone History

Fiscal Year	CD-0	Conceptual Design Complete	CD-1	CD-2	CD-3	CD-4
FY 2026	7/5/05	–	1/25/08	12/12/2023	12/12/2023	1Q FY 2040

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

Fiscal Year	Performance Baseline Validation	CD-1 Cost Range Update	CD-1R	CD-3A	CD-3B	CD-3C	CD-4
FY 2026	1/13/17	1/13/17	1/13/17	1/13/17	12/12/23	12/16/24	1Q FY 2040

CD-1R – Approve Alternative Selection and Cost Range, Revised; **CD-3A** – Approval of the project starting construction of original 2017 approved baseline; **CD-3B** - Approval of the project starting construction under the 2023 approved baseline; **CD-3C** – Approval of additional Long-Lead In-Kind Hardware Procurements in the following areas: Electron Cyclotron Heating, Tokamak Cooling Water System, Roughing Pump and Vacuum Auxiliary Systems; **CD-4** - Completion of In-kind Hardware Scope.

Project Cost History

At the time of CD-1 approval in January 2008, the preliminary cost range was $1,450,000,000 to $2,200,000,000. Until 2016, however, it was not possible to confidently baseline the project due to delays early in the international ITER construction schedule. Various factors (e.g., schedule delays, design and scope changes, funding constraints, regulatory requirements, risk mitigation, and inadequate project management and leadership issues in the IO at that time) affected the project cost and schedule. Shortly after the arrival of the new Director General in March 2015, the overall ITER Project was baselined for cost and schedule.

In response to a 2013 Congressional request, a DOE SC Independent Project Review (IPR) Committee assessed the project and determined that the existing cost range estimate of $4,000,000,000 to $6,500,000,000 would likely encompass the final TPC (includes SP-1, SP-2, and Cash Contributions). In preparation for baselining SP-1, based on the results of an Independent Project Review, the acting Director for the Office of Science updated the lower end of this range to reflect updated cost estimates, resulting in the current approved CD-1 Revised (CD-1R) range of $4,700,000,000 to $6,500,000,000.

FY 2023 reflects only SP-1 and associated cash contributions. Beginning in FY 2024, the entire U.S. ITER Project was baselined per Congressional direction in the Consolidated Appropriations Act, 2021. The TPC for the entire project is projected to be $6,500,000,000.

U.S. Contributions to ITER In-kind Hardware and Construction Cash Contributions

(dollars in thousands)

Fiscal Year	TEC, Design	TEC, Construction	TEC, Cash Contributions	TEC, Total	OPC, Except D&D	OPC, Total	TPC
FY 2025	439,243	4,677,455	1,313,000	6,429,698	70,302	70,302	6,500,000
FY 2026	439,243	4,677,455	1,313,000	6,429,698	70,302	70,302	6,500,000

2. Project Scope and Justification

ITER, currently one of the largest science experiments in the world, is a major fusion research facility under construction in St. Paul-lez-Durance, France by an international partnership of seven Members or domestic agencies, specifically, the U.S., China, the European Union, India, Korea, Japan, and the Russian Federation. ITER is co-owned and co-governed by the seven Members. The Energy Policy Act of 2005 (EPAct 2005), Section 972(c)(5)(C) authorized U.S. participation in ITER. The Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (Joint Implementation Agreement or JIA), signed on November 21, 2006, provides the legal framework for the four phases of the program: construction, operation, deactivation, and decommissioning. The JIA is a Congressional-Executive Hybrid Agreement. The other six Members entered the project by treaty. The IO is a designated international legal entity located in France.

Scope

U.S. Contributions to ITER – Construction Project Scope

The overall U.S. ITER project includes three major elements:

- In-kind Hardware systems (13 in total), built under the responsibility of the U.S., and then shipped to the ITER site for IO assembly, installation, and operation. Included in this element is cash provided in-lieu of U.S. in-kind component contributions to adjust for certain reallocations of hardware contributions between the U.S. and the IO.
- Funding to the IO to support common expenses, including ITER research and development (R&D), design and construction integration, overall project management, nuclear licensing, IO staff and infrastructure, IO-provided hardware, on-site assembly/installation/testing of all ITER components, installation, safety, quality control, and operation.
- Other Project Costs (OPC), including R&D (other than mentioned above) and conceptual design-related activities.

Justification

The purpose of ITER is to investigate and conduct research in the “burning plasma” regime—a performance region that exists beyond the current experimental state of the art. Creating a self-sustaining burning plasma will provide essential scientific knowledge necessary for practical fusion power. There are two planned experimental outcomes expected from ITER. The first is to investigate the fusion process in the form of a "burning plasma," in which the heat generated by the fusion process exceeds that supplied from external sources (i.e., self-heating). The second is to sustain the burning plasma for a long duration (e.g., several hundred to a few thousand seconds), during which time equilibrium conditions can be achieved within the plasma and adjacent structures. ITER will provide a sustained burning plasma for long-term experimentation which is a necessary step toward developing a fusion pilot plant.

Although not classified as a Capital Asset, the U.S. ITER project is being conducted following project management principles of DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets,* to the greatest extent possible.

Key Performance Parameters (KPPs)

The U.S. Contributions to ITER Project will not deliver an integrated operating facility, but rather in-kind hardware contributions, which represent a portion of the international ITER facility. The U.S. ITER project defines project completion as delivery and IO acceptance of the U.S. in-kind hardware.

3. Financial Schedule

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs	IRA Supp. Costs
Total Estimated Cost (TEC)				
Design (TEC)				
Prior Years	439,243	439,243	439,243	—
Total, Design (TEC)	**439,243**	**439,243**	**439,243**	**—**
Construction (TEC)				
Prior Years	1,449,877	1,449,877	1,126,459	43,449
Prior Years - IRA Supp.	190,000	190,000	—	—
FY 2024	202,500	202,500	13,058	141,580
FY 2025	144,000	144,000	144,000	4,971
FY 2026	77,500	77,500	77,500	—
Outyears	2,613,578	2,613,578	3,126,438	—
Total, Construction (TEC)	**4,677,455**	**4,677,455**	**4,487,455**	**190,000**
Cash Contributions (TEC)				
Prior Years	450,497	450,497	450,497	63,086
Prior Years - IRA Supp.	66,000	66,000	—	—
FY 2024	37,500	37,500	35,264	2,914
FY 2025	56,000	56,000	58,236	—
Outyears	703,003	703,003	703,003	—
Total, Cash Contributions (TEC)	**1,313,000**	**1,313,000**	**1,247,000**	**66,000**
Total Estimated Cost (TEC)				
Prior Years	2,339,617	2,339,617	2,016,199	106,535
Prior Years - IRA Supp.	256,000	256,000	—	—
FY 2024	240,000	240,000	48,322	144,494
FY 2025	200,000	200,000	202,236	4,971
FY 2026	77,500	77,500	77,500	—
Outyears	3,316,581	3,316,581	3,829,441	—
Total, Total Estimated Cost (TEC)	**6,429,698**	**6,429,698**	**6,173,698**	**256,000**

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs	IRA Supp. Costs
Other Project Cost (OPC)				
Prior Years	70,302	70,302	70,302	–
Total, Other Project Cost (OPC)	**70,302**	**70,302**	**70,302**	**–**

(dollars in thousands)

	Budget Authority (Appropriations)	Obligations	Costs	IRA Supp. Costs
Total Project Cost (TPC)				
Prior Years	2,409,919	2,409,919	2,086,501	106,535
Prior Years - IRA Supp.	256,000	256,000	–	–
FY 2024	240,000	240,000	48,322	144,494
FY 2025	200,000	200,000	202,236	4,971
FY 2026	77,500	77,500	77,500	–
Outyears	3,316,581	3,316,581	3,829,441	–
Total, TPC	**6,500,000**	**6,500,000**	**6,244,000**	**256,000**

Notes:
- *The entire project was baselined in December 2023 with a TPC of $6,500,000,000.*
- *All Appropriations to date for the U.S. Contributions to ITER project include both funding for SP-1 and funding for Cash Contributions, as well as for work associated with the new overall In-kind Hardware baseline.*
- *Obligations and costs through FY 2024 reflect actuals; obligations and costs for FY 2025 and the outyears are estimates.*

4. Details of Project Cost Estimate

The overall U.S. Contributions to ITER project has an approved revised CD-1R. Cost Range (CD-1R). In 2016, DOE chose to divide the project hardware scope into two distinct subprojects (First Plasma or SP-1, and Post-First Plasma or SP-2) so that an initial portion of the project that was mature enough to baseline could be accomplished. The baseline for SP-1 In-kind Hardware ($2,500,000,000) was approved in January 2017. In December 2023, per Congressional direction, the entire project was baselined with a total project cost of $6,500,000,000 and achieved CD-2/3B.

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			
Design	439,243	439,243	573,660
Design - Contingency	N/A	N/A	122,365
Total, Design (TEC)	**439,243**	**439,243**	**696,025**

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Construction	3,317,455	3,317,455	N/A
Equipment	N/A	N/A	1,362,521
Construction - Contingency	1,360,000	1,360,000	371,152
Total, Construction (TEC)	**4,677,455**	**4,677,455**	**1,733,673**
Cash Contributions	1,313,000	1,313,000	N/A
Total, Cash Contributions (TEC)	**1,313,000**	**1,313,000**	**N/A**
Total, TEC	**6,429,698**	**6,429,698**	**2,429,698**
Contingency, TEC	*1,360,000*	*1,360,000*	*493,517*
Other Project Cost (OPC)			
OPC, Except D&D	70,302	70,302	70,302
Total, Except D&D (OPC)	**70,302**	**70,302**	**70,302**
Total, OPC	**70,302**	**70,302**	**70,302**
Contingency, OPC	*N/A*	*N/A*	*N/A*
Total, TPC	**6,500,000**	**6,500,000**	**2,500,000**
Total, Contingency (TEC+OPC)	***1,360,000***	***1,360,000***	***493,517***

Notes:

- *In the table above, the previous total estimate includes cash contributions estimate to align with the TPC budget request. The "Original Validated Baseline" reflects SP-1 only.*
- *Current total estimated design reflects work done prior to CD-2/3. SP-2 design work is accounted for in TEC Construction as part of SP-1 scope approved at CD-2/3.*

5. Schedule of Appropriations Requests

(dollars in thousands)

Fiscal Year	Type	Prior Years	FY 2024	FY 2025	FY 2026	Outyears	Total
FY 2025	TEC	2,595,617	240,000	225,000	—	3,369,081	6,429,698
	OPC	70,302	—	—	—	—	70,302
	TPC	2,665,919	240,000	225,000	—	3,369,081	6,500,000
FY 2026	TEC	2,595,617	240,000	200,000	77,500	3,316,581	6,429,698
	OPC	70,302	—	—	—	—	70,302
	TPC	2,665,919	240,000	200,000	77,500	3,316,581	6,500,000

6. Related Operations and Maintenance Funding Requirements

The U.S. Contributions to ITER operations phase is to begin with initial integrated commissioning activities with an assumed useful life of 30 to 35 years. The fiscal year in which commissioning activities begin depends on the international ITER project schedule. As a result of COVID-19 and other known delays, the IO has submitted an overall ITER project updated cost and schedule to the ITER Council at the June 2024 meeting. This update indicates a start of commissioning activities after 2033.

Start of Operation or Beneficial Occupancy	1Q FY 2040
Expected Useful Life	35 years
Expected Future Start of D&D of this capital asset	1Q FY 2075

7. D&D Information

Since ITER is being constructed in France by a coalition of countries and will not be a DOE asset, the "one-for-one" requirement is not applicable to this project.

The U.S. Contributions to ITER decommissioning phase is assumed to begin no earlier than 30 years after the start of operations. The deactivation phase is also assumed to begin no earlier than 30 years after operations begin and will continue for a period of five years. The U.S. is responsible for 13 percent of the total decommissioning and deactivation cost; this requirement will be collected and escrowed out of Research Operations funding.

8. Acquisition Approach

The U.S. ITER Project Office (USIPO) at Oak Ridge National Laboratory, with its two partner laboratories (Princeton Plasma Physics Laboratory and Savannah River National Laboratory), will procure and deliver in-kind hardware in accordance with the Procurement Arrangements established with the IO. The USIPO will subcontract with a variety of research and industry sources for design and fabrication of its ITER components, ensuring that designs are developed that permit fabrication, to the maximum extent possible, to use fixed-price subcontracts (or fixed-price arrangement documents with the IO) based on performance specifications, or more rarely, on build-to-print designs. USIPO will use cost-reimbursement type subcontracts only when the work scope precludes accurate and reasonable cost contingencies being gauged and established beforehand. USIPO will use best value, competitive source-selection procedures to the maximum extent possible, including foreign firms on the tender/bid list when necessary. Such procedures shall allow for cost and technical trade-offs during source selection. For the large-dollar-value subcontracts (and critical path subcontracts as appropriate), USIPO will utilize unique subcontract provisions to incentivize cost control and schedule performance. In addition, where it is cost effective and it reduces risk, the USIPO will participate in common procurements led by the IO or request the IO to perform activities that are the responsibility of the U.S. SC will evaluate the Management and Operation (M&O) contractor's performance through the annual laboratory performance appraisal process.

SC and the M&O will draw from lessons learned from other SC projects and other similar facilities in planning and executing the project.