Fusion Energy Sciences

Overview

The Fusion Energy Sciences (FES) program is advancing in alignment with a set of national priorities that emphasize energy security, economic competitiveness, and U.S. technological leadership in accordance with the goals of the Department of Energy (DOE) Genesis Mission to integrate artificial intelligence (AI), high-performance computing, experimental facilities, and data infrastructure into a national discovery platform. The U.S. Fusion Science & Technology Roadmap (Roadmap) establishes a national strategy to close scientific and technological (S&T) gaps on the critical path toward fusion energy, supporting a new era of U.S. fusion energy leadership. In alignment with the DOE Genesis Mission Lighthouse Challenges, the AI-Fusion Digital Convergence Platform (DCP) will accelerate sustaining burning plasmas and materials discovery to harness fusion power using the most sophisticated AI models ever developed. Targeted Quantum Information Science (QIS) investments leverage transformative tools for plasma science, materials research, and diagnostics in extreme environments.

The FES mission is to drive the S&T foundation for a fusion energy source and support the development of a competitive U.S. fusion energy industry. The Roadmap is DOE's strategy to "Build", "Innovate", and "Grow" a leading, robust American fusion energy industry, and ensures that FES core research aligns with closing gaps along the critical path to fusion energy. It's six Core Challenge Areas are strongly aligned to the 2020 Fusion Energy Sciences Advisory Committee (FESAC) Long-Range Plan (LRP): structural materials, plasma-facing components and plasma-material interactions, confinement approaches, the fuel cycle, blankets, and fusion plant engineering and system integration.

FES supports advancing multiple confinement concepts. The Sustain a Burning Plasma element includes research and development (R&D) on U.S. world-leading short-pulse toroidal facilities (e.g., DIII-D and National Spherical Torus Experiment-Upgrade [NSTX-U]) that support AI-fusion convergence, optimize magnetic confinement regimes and test prototypic fusion technology, while also enabling international collaborations on long pulse facilities abroad. Inertial Fusion Energy (IFE) hubs support rapid growth of IFE approaches. U.S. participation in ITER provides U.S. scientists access to an industrial scale burning plasma experimental facility and helps build the American fusion energy supply chain. Fusion Innovation Research Engine (FIRE) Collaboratives bridge basic science with the needs of the growing fusion industry, to address S&T gaps informed by the private sector. Complementing FIRE is a suite of public-private partnership (PPP) programs. The Milestone-Based Fusion Energy Development Program supports fusion development companies to establish viable fusion pilot plant (FPP) designs. The Innovation Network for Fusion Energy (INFUSE) provides vouchers to fusion startups to access expertise and capabilities at national labs and universities. The Private Facility Research (PFR) program leverages private capital investment by supporting research on private facilities to advance S&T for public benefit. The Public Private Consortium Framework (PPCF) supports Fusion Bringing Regional Investments to Develop & Grow fusion Engines (Fusion BRIDGE) to cost-share small and medium-scale test stands to de-risk critical fusion materials and technologies.

Fusion Materials and Internal Components address the development of novel materials and technologies that can withstand enormous heat and neutron exposure. The Material Plasma Exposure eXperiment (MPEX) facility will address knowledge gaps in plasma-material interactions, and a new design activity to evaluate a mission need for a Fusion Prototypical Neutron Source (FPNS) to address the highest priority facility need identified by the FESAC LRP. Closing the Fusion Cycle develops the breeding and processing technology for fusion fuels that ensure fusion is a self-sustaining energy source. This includes a strategy to develop test stands and components along a path to developing integrated blanket and fuel cycle testing capabilities.

FES supports fusion theory and simulation to enable prediction and interpretation of complex plasma phenomena and fusion technology, and to provide validated 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.

FES supports plasma science and technology research areas such as plasma astrophysics, space plasmas, plasma propulsion, high-energy-density laboratory plasmas (HEDLP), and low-temperature plasmas. Practical societal applications of plasmas are found in plasma processing of advanced materials, plasma-enabled chemical processing, and plasma medicine.

Within SC, FES invests in several cross-cutting initiatives such as AI and machine learning (AI/ML), QIS, and microelectronics. With continued funding for the Established Program to Stimulate Competitive Research (EPSCoR), FES builds strategic programs to enhance SC-sponsored fusion-relevant research in key states and territories.

Highlights of the FY 2027 Request

The FES FY 2027 Request of $755.3 million is a decrease of $50.406 million below FY 2026 Enacted, with reduced funding for core research to offset increases for high priority research activities and facility operations. The Request is aligned to support the overall U.S. fusion strategy and the Roadmap, including reviewing partnerships and investment approaches to quickly advance fusion energy. The Request aligns with recommendations in the FESAC LRP. The FY 2027 Request includes:

Research

- DIII-D research: Exploit novel heating and current drive systems to test, integrate, and demonstrate advanced operation of these systems in support of the global supply chain for plasma actuators. Support publicly and privately funded facility users to close high priority gaps for pulsed and steady-state tokamak operational scenarios.
- NSTX-U research: Begin NSTX-U plasma experiments. Support collaborative research related to the optimization of tokamak aspect ratio and high field conventional tokamak studies in support of FPP development.
- 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 the INFUSE program; and support the PFR program, where private fusion companies offer their facilities at no cost to public sector sponsored researchers to perform mutually beneficial, open research. In addition, Fusion BRIDGE explores modalities that support PPPs and regional consortia aimed at developing and building small, medium, and large-scale capabilities, including test stands. These efforts are targeted toward closing critical Fusion Materials and Technology (FM&T) gaps defined by both the public and private sectors.
- IFE: Expand research activities, including the IFE Science & Technology Accelerated Research (STAR) hubs and the IFE ecosystem stewardship. Additionally, initiate advanced modeling, simulation, and AI/ML capabilities to bridge S&T gaps and accelerate the development of an IFE FPP.
- FIRE Collaboratives: Strengthen support for the multi-institutional, multi-disciplinary R&D efforts to address critical S&T gaps outlined in the FESAC LRP and support public and private FPP efforts. The Request supports multiple collaboratives in four technical areas: advanced simulation, materials, blanket/fuel cycle, and enabling technologies.
- Fusion Materials and Internal Components: Initiate evaluation of a mission need for a FPNS facility. FPNS was the highest priority new facility in the FESAC LRP. The FPNS facility would enable investigation of the effects of fusion-relevant irradiation on material properties degradation in this harsh burning plasma environment. This capability will provide a better understanding of materials performance and lifetime limits from an engineering science perspective as well as supporting the development of structural and plasma facing materials for use in a next-step fusion device.
- Closing the Fusion Cycle: Initiate design of an Integrated Blanket and Fuel Cycle Test Facility (IB-FCTF), consistent with recent FESAC reports and following design and cost estimate work in FY 2026. The

approach to delivering an IB-FCTF will be a phased approach that delivers component capabilities integrated over time, to support closing the critical S&T gaps identified in the Roadmap blanket and fuel cycle core challenges in both the areas of tritium breeding capabilities of various blanket concepts and the development of the fuel processing technology to separate and process the tritium to make fusion an inexhaustible energy resource for the future.

- 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 and plasma astrophysics research including multi-island magnetic reconnection and coronal heating, collaborative research facilities including the Facility for Laboratory Reconnection Experiment (FLARE), HEDLP research including utilizing the Matter in Extreme Conditions (MEC) instrument at the SLAC Linac Coherent Light Source (LCLS), and LaserNetUS facilities, microelectronics research and centers, plasma-based technology research, and QIS research.
- Theory and Simulation: Continue aligning foundational theory and computational simulation efforts with FES priorities in the realms of plasma confinement, digital engineering, and development of FPPs.
- AI/ML: Increase support for multi-disciplinary teams applying AI/ML for science discovery through foundational models, model extraction through surrogates of high-fidelity simulations, data-enhanced prediction and autonomous plasma control, facility operations, and modeling of manufacturing and supply chain logistics. Advance the AI-Fusion DCP as called for in the Roadmap, in support of the Genesis Mission.
- 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 including electron cyclotron heating enhancements.
- NSTX-U recovery and operations: Complete the recovery and repair activities including machine assembly. Commission all systems and begin experimental plasma operations.
- Material Plasma Exposure eXperiment (MPEX): After completion of the MPEX project, initiate preparation for operation of this facility.

Projects

- U.S. hardware development and delivery to ITER: Support the continued design and fabrication of multiple in-kind hardware with no cash contribution. Realign project with reassessment of how ITER fits in the overall U.S. fusion strategy, including reviewing partnerships and investment approaches to quickly advance fusion energy.

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 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Fusion Energy Sciences				
Theory and Simulation	64,000	65,776	72,540	+6,764
Fusion Materials and Internal Components	85,000	76,411	68,000	-8,411
Sustain a Burning Plasma	123,000	141,661	140,000	-1,661
Closing the Fusion Cycle	69,000	56,238	89,000	+32,762
Discovery Plasma Science and Technology	48,000	65,000	55,900	-9,100
Public-Private Partnerships	71,200	100,000	135,000	+35,000
FES Established Program to Stimulate Competitive Research (EPSCoR)	2,000	2,000	2,000	–
Other Research	3,890	3,687	6,311	+2,624
Total, AT80 - Fusion and Plasma Research	**466,090**	**510,773**	**568,751**	**+57,978**
DIII-D Operations	71,600	74,000	61,000	-13,000
National Spherical Torus Experiment-Upgrade (NSTX-U) Operations	52,310	50,200	47,000	-3,200
MPEX Operations	–	–	1,000	+1,000
Total, AT81 - Fusion Facility Operations	**123,910**	**124,200**	**109,000**	**-15,200**
Subtotal, Fusion Energy Sciences	**590,000**	**634,973**	**677,751**	**+42,778**
Construction				
14-SC-60 US Contributions to ITER	200,000	170,684	77,500	-93,184
Subtotal, Construction	**200,000**	**170,684**	**77,500**	**-93,184**
Total, Fusion Energy Sciences	**790,000**	**805,657**	**755,251**	**-50,406**

Fusion Energy Sciences
Explanation of Major Changes

	(dollars in thousands)
	FY 2027 Request vs FY 2026 Enacted
Fusion and Plasma Research	**+$57,978**

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, begin preparations for utilizing NSTX-U as it moves closer to startup of plasma operations, 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 Milestone-Based Fusion Development Program, continues support for Materials and increases support for Closing the Fusion Cycle consistent with the FESAC LRP goals with a focus on delivering small to medium scale experimental capabilities aligned with the Roadmap using multiple modalities, tools, and approaches. Initiate design of an IB-FCTF that will help close the S&T gaps in the blanket and fuel cycle areas. 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 Roadmap Core Challenge Areas. The Request increases support for IFE S&T in IFE STAR hubs, increases 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 the PFR program for fusion community to perform research on private fusion and plasma science facilities. It also enhances support for the Fusion BRIDGE activity, to explore models that support PPPs towards developing innovative partnerships and regional consortia to building small, medium, and large-scale capabilities, including test stands targeted toward closing key FM&T gaps identified in the Roadmap. 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 also supports Future Facilities Studies program focusing on new strategic experimental facilities addressing S&T gaps identified in the FESAC LRP and the Roadmap.

For General Plasma Science and Technology, the Request emphasizes user research on collaborative research facilities at universities and national laboratories including the FLARE at PPPL and work in emerging plasma technology topics. For HEDLP, the Request continues support for research utilizing the MEC instrument and 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 maintains support for QIS, which supports the

	(dollars in thousands)
	FY 2027 Request vs FY 2026 Enacted
Fusion and Plasma Research core research portfolio stewarded by FES and the National QIS Research Centers. Support continues for EPSCoR.	**+$57,978**
Fusion Facility Operations The Request will support NSTX-U Recovery completion involving final stages of machine assembly, system commissioning, and start of 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. Oak Ridge National Laboratory (ORNL) will initiate preparation for the startup of operation of the MPEX device.	**-$15,200**
Construction 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.	**-$93,184**
Total, Fusion Energy Sciences	**-$50,406**

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 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 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 HEDLP science and continues to coordinate research activities with the Advanced Research Projects Agency-Energy (ARPA-E).

Program Accomplishments
SciDAC Advances in Fusion Simulation
Through the SciDAC program, researchers are transforming how fusion reactors are modeled and designed. A partnership led by the University of California at San Diego has developed AI-driven reduced models that can rapidly predict transport in tokamaks by combining experimental datasets with the power of high-performance computing (HPC). In parallel, a team led by ORNL has achieved a breakthrough by integrating high-fidelity plasma simulation codes with commercial engineering tools from Ansys, enabling streamlined calculations of plasma instabilities and their impact on liquid metal blankets and structural components. Together, these advances mark a new era where AI, HPC, and engineering-grade simulation converge to accelerate the path to practical fusion energy.

Artificial Intelligence in Fusion Energy
AI is rapidly reshaping the frontier of fusion research. At ORNL, scientists have created a powerful AI toolkit that leverages vast experimental datasets to accurately predict fusion experiment pulses, giving researchers a new edge in planning and control. At PPPL, teams are constructing a fusion-dedicated, AI-optimized supercomputing cluster equipped with cutting-edge graphics processing units (GPUs), designed to accelerate predictive simulations and strengthen collaboration with private fusion companies on FPP design. Meanwhile, researchers at the University of Texas at Austin have harnessed AI/ML alongside analytic theory and simulation to resolve a decades-old challenge in high-energy particle confinement—a landmark advance that pushes theory into the era of AI-enabled discovery. Together, these breakthroughs signal a decisive shift toward an AI-powered fusion ecosystem capable of speeding progress from experiment to deployment.

Morphology of Copper Nanofoams for Inertial Fusion Energy
Scientists at Los Alamos National Laboratory (LANL), SLAC National Accelerator Laboratory, Brigham Young University, and Lawrence Livermore National Laboratory (LLNL) have utilized a powerful technique called 3D Ptychotomography at an X-ray Free Electron Laser (XFEL) to investigate the nanostructure of copper foams for fusion applications. Their groundbreaking research, published in Nano Letters, reveals unexpected morphological complexities, such as distorted, merged, or open shells, and a mass density lower than targeted. This unprecedented nanoscale information is critical for improving foam modeling and fabrication methods, paving the way for tailored materials that can significantly enhance the performance of IFE and related experiments.

Correlated x-ray pairs generated at an XFEL for the first time
A SLAC-led collaboration has achieved the first observation of correlated X-ray pairs generated at an XFEL, consistent with quantum entanglement, by utilizing parametric down-conversion at a Japanese XFEL facility. This breakthrough, which validates the production of X-ray pairs even with XFEL's ultrashort pulses, paves the way for quantum-enhanced X-ray imaging with reduced dose and noise, and advancements in QIS.

Simulating Plasma Wave Propagation on a Superconducting Quantum Chip

Researchers from Rigetti Computing, LLNL, and the University of Colorado at Boulder have achieved the first quantum simulation of plasma waves. They used Rigetti's Ankaa-3 superconducting quantum computer to model plasma wave propagation and scattering in a non-uniform medium, identifying a quantum model of magnetism that mimics plasma behavior. This approach offers computational advantages over classical methods, particularly for simulating nonlinear quantum effects in high-energy, high-density plasmas. The project, which also involved developing a regression technique for error mitigation, marks a significant step toward using quantum computing for complex multiscale, multi-physics problems in fusion energy, nuclear science, chemistry, and materials science.

Surprising energy cascade transfer pathways in solar wind plasmas
Researchers from LANL and the University of Delaware have employed a new scale decomposition method to investigate turbulence in wavenumber-frequency space. This has enabled, for the first time, the investigation of the turbulent energy transfer in spatial and temporal domains. In contrast, most of the previous methods have focused only on the spatial transfer. One new result from this investigation is that magnetic fluctuations with timescales longer than the nonlinear timescale exhibit an inverse cascade toward smaller frequencies. Higher frequency magnetic modes, on the other hand, undergo a forward cascade. Detailed analysis suggests that the low frequency solar wind fluctuations may have originated locally through turbulence inverse cascade. Turbulence is ubiquitous in astrophysical and laboratory plasmas including fusion, with its hallmark characteristic of cascading the injected energy to small spatial scales.

A three-theory problem for the observed temperatures inside a spherical tokamak
Using sophisticated simulations of small fluctuations within previous NSTX test results, researchers identified a third possible explanation for the observed temperature profiles. Specifically, the simulation results show that internal turbulence driven by high internal pressures can exhibit the observed electron temperature profile behavior during strong external heating. Initial theoretical work identified instabilities caused by fast injected particles as a possible cause. More recently, global instabilities showed promise. Once operational, experimentation on NSTX-U will provide definitive evidence to determine which of the three theories is correct.

Fusion Energy Sciences
Fusion and Plasma Research

Description

This subprogram advances our scientific understanding of how to control and sustain a burning plasma, a critical step along the path to fusion power plants, utilizing both simulation and experimental results from domestic and international devices. The subprogram supports closing critical science, materials and technology gaps that must be closed for fusion energy development, such as the breeding and handling of fusion fuels, the development of the required materials, and breeding blanket and fusion fuel-cycle technology that can withstand the harsh fusion environment and harness fusion power. 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 and capabilities. 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 FIRE Collaboratives provide coordination among program elements to address critical scientific and technology gaps in fusion energy. The Fusion BRIDGE supports development of regional consortia and new public-private partnership modalities to deliver small-to-medium test stands aligned with the Fusion S&T Roadmap core challenge areas, and 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 SciDAC program, in partnership with the Advanced Scientific Computing Research (ASCR) program, to accelerate scientific discovery in fusion plasma S&T. This activity also includes support for advancing the AI-Digital Convergence Platform as part of the Genesis Mission, and the FIRE Collaboratives for advanced simulations for design and optimization, which addresses critical scientific gaps for FPP concepts in coordination with the other FIRE Collaboratives. This program supports the application of AI/ML techniques encompassing multiple 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 MPEX Major Item of Equipment (MIE) project, which is a new U.S. materials experimental capability initiated in FY 2019 with expected operation in late FY 2027/early FY 2028 time-frame, 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. In addition, a new design activity will be initiated on a FPNS which was considered by the FESAC LRP to be the highest priority new FES facility.

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 program includes traditional toroidal confinement approaches such as advanced tokamaks (ATs), spherical tokamaks (STs), high magnetic field tokamaks, 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 program 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, with the dual aims of sustaining U.S. scientific leadership and preparing the foundation for an FPP. Built around long-pulse, burning plasma relevant conditions, the program integrates experiments, advanced diagnostics, theory, and simulation to close critical gaps in the physics basis for burning plasmas. Its scope spans five major research divisions (sustaining burning plasma, handling power and particle exhaust, advancing plasma–material interactions, controlling damaging transients, and validating theory and modeling) supported by crosscutting activities in magnetic confinement technology, engineering, and operations. The Theory and Model Validation topic encompasses AI/ML applications, integrated control, and model verification efforts that tie experiments to predictive capabilities developed in the Theory and Simulation program areas. Research is carried out across U.S. facilities like the DIII-D National Fusion Facility (an Office of Science (SC) user facility) and the Helically Symmetric Experiment (HSX) as well as through strong collaborations on leading international superconducting tokamaks and stellarators such as the JT-60SA in Japan, and the Wendelstein 7-X (W7-X) in Germany, ensuring broad engagement of national laboratories, universities, and industry. Together, the TLP Program provides the scientific knowledge, technology pathways, and coordinated structure necessary to accelerate the nation's progress toward practical fusion energy.

The Compact Toroidal Concepts (CTC) area supports research necessary to develop a compact toroidal configuration. Two promising concepts addressed in CTC are the ST, such as the NSTX-U, and conventional aspect ratio tokamaks operated at high magnetic fields, exemplified by Commonwealth Fusion Systems' 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 magnet technology. Regardless of the approach, enabling technologies are essential for delivering these compact designs, including high-temperature superconducting magnets, and liquid metal plasma-facing components. 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, developing high repetition rate drivers, 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, focused on delivering novel systems for measurements in an FPP.

The Future Facilities Studies area supports studies and research for required facilities that "best serve fusion" and facilitate the development of fusion energy while addressing needs of both the public and private sectors aligned with the FESAC LRP in 2020 and the FESAC Facilities Construction Projects Subcommittee Draft Report in 2024.

Closing the Fusion Cycle

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 area supports enabling R&D, fusion nuclear science, FIRE Collaboratives, and research capabilities to advance the readiness of these critical capabilities. Research areas include initiating the design of an integrated blanket/fuel cycle facility as a MIE project that will support addressing a number of these critical scientific challenges. In addition, a new research effort will be initiated to evaluate various possible options for a neutron source that could enable testing of both structural/plasma facing materials and blanket concepts in a fusion-relevant environment.

Discovery Plasma Science and Technology

Discovery Plasma Science and Technology (DPST) research supports activities in HEDLP, foundational plasma science research, transformational plasma S&T, innovation in advanced microelectronics, and efforts in the convergence of plasmas and QIS.

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 S&T 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 S&T 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 area supports discovery plasma research in a multi-disciplinary, co-design framework to accelerate plasma-based microelectronics fabrication and advance the development of microelectronic technologies. This activity also supports the DOE Microelectronics Science Research Centers.

Quantum Information Science (QIS) area 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. This activity also supports the portfolio of DOE National QIS Research Centers.

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 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 in a manner that maintains control over proprietary information.

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 an 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. 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 Public Private Consortium Framework (PPCF) supports modalities such as Fusion BRIDGE which seeks to develop a network of regional activities to accelerate cost-sharing to deliver and operate small and medium-scale test stands to de-risk most common and critical Fusion Materials and Technology (FM&T) gaps. Fusion BRIDGE supports regional consortia efforts with seed funding meant to catalyze cost share and regional investments in projects, to build industry-led development of test stands 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 Private Facilities Research (PFR) Program offers researchers from DOE national laboratories and U.S. universities the opportunity to conduct non-proprietary open scientific studies on privately constructed facilities for the mutual benefit of all parties. All funding is directed to the public sector. Private companies offer the public sector experimental access to their facilities at no cost, allowing the public sector to leverage billions of dollars in private investment. The private sector benefits as researchers maximize their device performance toward realizing investor goals, and the public benefits by open publishing of research results.

Established Program to Stimulate Competitive Research (EPSCoR)
The Established Program to Stimulate Competitive Research (EPSCoR) provides opportunities to U.S. regions with potential to build critical expertise and capacity.

Other Research
This area supports the Postdoctoral Research Program, 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.

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted		FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Fusion and Plasma Research	**$510,773**	**$568,751**	**+$57,978**
Theory and Simulation	$65,776	$72,540	+$6,764
Funding supports 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.		The Request will continue to support efforts focused on the fundamental theory of fusion plasmas, high-fidelity simulations of plasmas and their associated facilities, a new round of FES/ASCR SciDAC Partnerships, the development of advanced simulation tools for the FIRE Collaboratives and AI/ML research in cross-cutting interdisciplinary fusion energy, plasma science, and digital engineering research supporting AI-Fusion Digital Convergence Platform within the Genesis Mission.	Prioritization with theory and SciDAC will align this research with LRP priorities. Funding will continue to support FIRE Collaboratives. Funding for AI/ML research will align with Genesis Mission and FPP design efforts.
Fusion Materials and Internal Components	$76,411	$68,000	-$8,411
Funding enables growth in the key area of materials which is critical in de-risking gaps for fusion energy. Funding continues to support the FIRE Collaboratives for structural and plasma facing materials. Funding also continues to support the MPEX MIE project, consistent with the approved baseline for the project.		The Request will continue to support the FIRE Collaboratives for structural and plasma-facing materials and the growth of small-to-medium scale testing capabilities necessary for the development and evaluation of fusion materials. The Request will continue to support both the MPEX MIE project and research activities. The Request includes funding to support design and mission need activities for a FPNS.	Funding will continue to support the highest priority research activities on structural and plasma-facing materials to address the scientific/technical gaps outlined in the FS&T Roadmap. The decrease in funding reflects the expectation that the MPEX MIE project will be completed in late FY 2027 to early FY 2028-time frame.

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Sustain a Burning Plasma $141,661	$140,000	-$1,661
Funding supports research efforts at DIII-D and lays the groundwork for the initiation of NSTX-U research activities. Funding supports small-scale U.S. experimental facilities to help close scientific gaps, supports research on international facilities for both tokamak and stellarator 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.	The Request will continue support for research at DIII-D and continued NSTX-U research. The Request supports small-scale U.S. experimental facilities to help close scientific gaps, supports research on international facilities for both tokamak and stellarator concepts, and supports priority R&D in breakthrough technologies in IFE and Measurement Innovation defined by the FS&T Roadmap.	Funding will support DIII-D and NSTX-U platforms aligned with priorities in FESAC LRP and support for Genesis Mission data mining. IFE and Measurement Innovation R&D will continue to be aligned with priorities in IFE development and critical diagnostic tools for FPPs.
Closing the Fusion Cycle $56,238	$89,000	+$32,762
Funding supports 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.	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. The Request will also include an initial investment in a blanket/fuel cycle test facility and neutron source infrastructure.	Funding increase will support new fusion technology capabilities necessary to close key gaps in blanket and fusion fuel cycle including initiating design activities for a future blanket/fuel cycle test facility as a Major Item of Equipment project consistent with the FS&T Roadmap.
Discovery Plasma Science and Technology $65,000	$55,900	-$9,100
Funding continues to support basic and translational science and MEC and LaserNetUS operations in HEDLP. In GPST, funding continues to support basic and low temperature plasma science as well as operations of research facilities. For Advanced Microelectronics, funding continues to support the centers selected in FY 2025 and the priority research opportunities identified in the recent workshop. For QIS, funding continues	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	Funding will support the highest-priority activities including QIS, plasma technology, and the PPPL Facility for Laboratory Reconnection Experiments (FLARE).

FY 2026 Enacted	FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
to support the research awards as well as the National QIS Research Centers.	workshop. For QIS, it will continue to support the research awards as well as the National QIS Research Centers.	
Public-Private Partnerships $100,000	$135,000	+$35,000
Funding supports PPPs through the Fusion Development Milestone Program, the INFUSE program, and the PFR program which started as a pilot program in FY 2025. Funding is also allocated to Fusion BRIDGE to support PPPs towards developing and building small-to-midscale capabilities.	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 the PPCF to support PPPs through Fusion BRIDGE 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, a new modality under the PPCF.
Established Program to Stimulate Competitive Research (EPSCoR) $2,000	$2,000	$ —
Funding continues to support EPSCoR State-National Laboratory Partnership awards and early career awards.	The Request will continue to support EPSCoR Implementation awards and early career awards.	No change.
Other Research $3,687	$6,311	+$2,624
Funding continues to support programmatic activities and infrastructure improvements.	The Request will continue to support programmatic activities and infrastructure improvements.	Funding will support the highest priority activities aligned with FESAC LRP.

Description

The DIII-D National Fusion Facility and the NSTX-U facility are world-leading 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 (FS&T) recommendation to "utilize research operations on DIII-D and NSTX-U, and collaborate with other world-leading facilities, to ensure that 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 S&T 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. The MPEX, which is being built at Oak Ridge National Laboratory (ORNL), will be able to address critical fusion materials science questions on the path toward proving the scientific viability of fusion power. MPEX will allow for dedicated studies of reactor-relevant heat and particle loads on neutron-irradiated materials. The overall motivation is to enter into a new class of fusion materials science wherein the combined effects of fusion-relevant heat, particle, and neutron fluxes can be studied for the first time anywhere in the world. It will provide a world-leading, highly cost-effective experimental device with superior capability, high throughput, and versatility. With the FY 2027 Request, MPEX will begin preparations for its initial operation.

DIII-D Operations

The DIII-D scientific user facility at General Atomics is the most adaptable and best-diagnosed magnetic confinement facility in the U.S. Its advanced diagnostics, evolving heating and current drive systems, and broad research team make it ideal for closing critical science and technology gaps pursued by the TLP program and enabling extrapolation to burning plasma conditions. In FY 2025, DIII-D operated and upgraded the facility while supporting 833 users from 128 institutions across 21 countries, including 40 faculty and 204 students—one of the largest U.S. fusion workforce contributions.

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 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 and greater stability at high pressure 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.

MPEX Operations

MPEX, at ORNL, will be a world-leading experimental capability to explore solutions to the plasma materials interactions challenge. When fully operational, this facility will enable dedicated studies of reactor-relevant plasma-material interactions at a scale not previously accessible to any fusion research program. The key research objective is to create a new class of fusion materials science enabling the study of the combined effects of fusion-relevant heat, particles, and neutron fluxes for the first time anywhere in the world.

Fusion Energy Sciences
Fusion Facility Operations

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted		FY 2027 Request	Explanation of Changes FY 2027 Request vs FY 2026 Enacted
Fusion Facility Operations	**$124,200**	**$109,000**	**-$15,200**
DIII-D Operations	$74,000	$61,000	-$13,000
Funding supports 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 continues for enhancements to the DIII-D electron heating system, up to ten gyrotrons providing 7 MW of injected power.		The Request will support 16 weeks of operations at the DIII-D facility, including exploitation of increased plasma heating and current drive capabilities and further studies aimed at exploring novel strategies for handling heat and particle fluxes in the tokamak divertor including negative triangularity shaped plasmas.	Funding will support the highest priority work elements of plasma heating and divertor systems. Facility operating time is prioritized.
National Spherical Torus Experiment-Upgrade (NSTX-U) Operations	$50,200	$47,000	-$3,200
Funding supports NSTX-U Recovery fabrication and machine reassembly activities.		The Request will support NSTX-U Recovery completion involving final stages of machine assembly, system commissioning, and start of plasma operations.	Funding will support the highest priority work elements of the NSTX-U Recovery effort and start of operations.
MPEX Operations	$ —	$1,000	+$1,000
		The Request will support MPEX start-up operations including hiring and training of operators and diagnosticians, support for MPEX staff, purchase of consumable supplies, equipment maintenance, and exploitation of the surface analysis station.	Funding will support getting this new facility ready for operations.

Description

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

14-SC-60 US 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. U.S. companies, DOE labs and U.S. universities contribute to the design, fabrication, and delivery of in-kind hardware for ITER.

The FY 2027 Request of $77,500,000 will support the continued systems design, fabrication, and delivery of in-kind hardware with no cash contribution. 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.

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

Activities and Explanation of Changes

(dollars in thousands)

FY 2026 Enacted		FY 2027 Request	Explanation of Major Changes FY 2027 Request vs FY 2026 Enacted
Construction	**$170,684**	**$77,500**	**-$93,184**
14-SC-60 U.S. Contributions to ITER U.S. ITER	$170,684	$77,500	-$93,184
Funding supports continued design and fabrication of in-kind hardware systems.		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 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Capital Operating Expenses						
Capital Equipment	N/A	N/A	46,400	49,380	31,200	-18,180
Minor Construction Activities						
General Plant Projects	N/A	N/A	–	–	2,000	+2,000
Total, Capital Operating Expenses	**N/A**	**N/A**	**46,400**	**49,380**	**33,200**	**-16,180**

Capital Equipment

(dollars in thousands)

	Total	Prior Years	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Capital Equipment						
Major Items of Equipment						
Fusion and Plasma Research						
Material Plasma Exposure eXperiment (MPEX)	194,036	139,656	22,200	25,180	7,000	-18,180
Total, MIEs	194,036	139,656	22,200	25,180	7,000	-18,180
Total, Non-MIE Capital Equipment	N/A	N/A	24,200	24,200	24,200	–
Total, Capital Equipment	**N/A**	**N/A**	**46,400**	**49,380**	**31,200**	**-18,180**

Note:
- The Capital Equipment table includes MIEs with a Total Estimated Cost (TEC) > $10M.

Fusion Energy Sciences
Major Items of Equipment Description(s)

Fusion Materials and Internal Components MIEs:

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 last year of funding for the MPEX project was expected to be in the FY 2026 Request. However, due to the increase in costs of the project, it will need additional resources above the current TPC in FY 2027. The CD-4 "Project Completion" date is still January 2028 which includes several months of schedule contingency. 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. In the FY 2027 Request, there is funding to initiate the required preparations to begin operations. This activity is in the Facility Operations part (MPEX Operations) of the FY 2027 Request.

Closing the Fusion Cycle

Integrated Blanket and Fuel Cycle Test Facility (IB-FCTF)

While previous public sector investments have provided a strong basis in the areas of plasma confinement and plasma enabling technologies, large gaps remain in the areas of power generation and sustainable closure of the fuel cycle, both of which strongly influence the economic, safety, and environmental attractiveness of fusion systems. Addressing the challenges of closing these technology gaps from a relatively low level of maturity to the level needed to design, build and operate a fusion pilot plant (FPP) requires an integrated testing capability. The IB-FCTF would be a world-leading facility that would provide the FES program with the capability needed to sufficiently retire the risks associated with moving forward with immature and incomplete blanket and fuel cycle systems. In the FY 2027 Request, there is a funding request of $8,000,000 for OPC to continue design activities to evaluate fully the possible options to build such a facility.

Fusion Energy Sciences
Construction Projects Summary

(dollars in thousands)

	Total	Prior Years	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
14-SC-60, U.S. Contributions to ITER						
Total Estimated Cost (TEC)	6,429,698	2,835,617	200,000	170,684	77,500	-93,184
Other Project Cost (OPC)	70,302	70,302	-	-	-	-
Total Project Cost (TPC)	**6,500,000**	**2,905,919**	**200,000**	**170,684**	**77,500**	**-93,184**
Total, Construction						
Total Estimated Cost (TEC)	**N/A**	**N/A**	**200,000**	**170,684**	**77,500**	**-93,184**
Other Project Cost (OPC)	**N/A**	**N/A**	**-**	**-**	**-**	**-**
Total Project Cost (TPC)	**N/A**	**N/A**	**200,000**	**170,684**	**77,500**	**-93,184**

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 2025 Enacted	FY 2025 Current	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Scientific User Facilities - Type A					
DIII-D National Fusion Facility	**114,600**	**118,254**	**96,668**	**95,000**	**-1,668**
Number of Users	550	833	550	500	-50
Achieved Operating Hours	–	716	–	–	–
Planned Operating Hours	640	640	640	640	–
Unscheduled Down Time Hours	–	125	–	–	–
National Spherical Torus Experiment-Upgrade	**82,310**	**87,123**	**68,852**	**72,000**	**+3,148**
Number of Users	380	347	380	350	-30
Total, Facilities	**196,910**	**205,377**	**165,520**	**167,000**	**+1,480**
Number of Users	930	1,180	930	850	-80
Achieved Operating Hours	–	716	–	–	–
Planned Operating Hours	640	640	640	640	–
Unscheduled Down Time Hours	–	125	–	–	–

Notes:

- *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.*
- *MPEX operations funding will cover start-up operations, including staffing (hiring, training, and support), consumable supplies, equipment maintenance, and surface analysis station exploitation.*

Fusion Energy Sciences
Scientific Employment

	FY 2025 Enacted	FY 2026 Enacted	FY 2027 Request	FY 2027 Request vs FY 2026 Enacted
Number of Permanent Ph.Ds (FTEs)	1,141	1,145	1,065	-80
Number of Postdoctoral Associates (FTEs)	141	145	118	-27
Number of Graduate Students (FTEs)	380	384	349	-35
Number of Other Scientific Employment (FTEs)	1,703	1,715	1,560	-155
Total Scientific Employment (FTEs)	**3,365**	**3,389**	**3,092**	**-297**

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

14-SC-60 US Contributions to ITER
Project is for Design and Construction

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

Summary

The FY 2027 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 with an expected CD-4 in 1Q 2040. 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.

Significant Changes

The U.S. ITER project was initiated in FY 2006. The most recent DOE Order 413.3B approved Critical Decision (CD) is CD-3C, Approve Long Lead Procurements, which was approved on December 16, 2024.

On January 13, 2017, U.S. ITER SP-1 achieved CD-2, Approve Performance Baseline, and CD-3, Approve Start of Construction. CD-4, Project Completion, for SP-1 was planned for December 2028. 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 re-baselining 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 2025, one Central Solenoid Module (CSM) was delivered to the IO, bringing the total to five of seven that make up the Central Solenoid Magnet (including one spare). In FY 2026, the final two CSMs are scheduled to arrive at the IO. In FY 2025, the delivery of central solenoid pre-compression and support structures to the IO were completed; the largest procurement for the Electron Cyclotron Heating (ECH) system, waveguides, was awarded; and the Tokamak Exhaust Processing final design review was completed. The FY 2026 funding supports the completion of the Vacuum Auxiliary System and Roughing Pump System design and the delivery of the ECH miter bends to the IO. The FY 2027 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 2027	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 2027	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. 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 2026	439,243	4,677,455	1,313,000	6,429,698	70,302	70,302	6,500,000
FY 2027	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	1,652,377	1,652,377	1,139,517	—
Prior Years - IRA Supp.	190,000	190,000	—	185,029
FY 2025	144,000	144,000	183,356	4,971
FY 2026	170,684	170,684	170,684	—
FY 2027	77,500	77,500	77,500	—
Outyears	2,442,894	2,442,894	2,916,398	—
Total, Construction (TEC)	**4,677,455**	**4,677,455**	**4,487,455**	**190,000**
Cash Contributions (TEC)				
Prior Years	487,997	487,997	485,761	—
Prior Years - IRA Supp.	66,000	66,000	—	66,000
FY 2025	56,000	56,000	56,347	—
FY 2026	—	—	1,889	—
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	2,579,617	2,579,617	2,064,521	—
Prior Years - IRA Supp.	256,000	256,000	—	251,029
FY 2025	200,000	200,000	239,703	4,971
FY 2026	170,684	170,684	172,573	—
FY 2027	77,500	77,500	77,500	—
Outyears	3,145,897	3,145,897	3,619,401	—
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	2,649,919	2,649,919	2,134,823	–
Prior Years - IRA Supp.	256,000	256,000	–	251,029
FY 2025	200,000	200,000	239,703	4,971
FY 2026	170,684	170,684	172,573	–
FY 2027	77,500	77,500	77,500	–
Outyears	3,145,897	3,145,897	3,619,401	–
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, 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**
Construction_No_Detail	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

(dollars in thousands)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
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 2025	FY 2026	FY 2027	Outyears	Total
FY 2026	TEC	2,835,617	200,000	77,500	—	3,316,581	6,429,698
	OPC	70,302	—	—	—	—	70,302
	TPC	2,905,919	200,000	77,500	—	3,316,581	6,500,000
FY 2027	TEC	2,835,617	200,000	170,684	77,500	3,145,897	6,429,698
	OPC	70,302	—	—	—	—	70,302
	TPC	2,905,919	200,000	170,684	77,500	3,145,897	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 the 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.